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Last Great Step at Panama The blowing up of Gamboa Dike on Oct. 10, signalizing the termination of dry excavation in Culebra Cut and the connection of the oceans by a waterway, marks the last of the great construction steps in the history of the Panama Canal. From now on the work will consist largely of putting on the finishing touches, completing works already practically finished, and providing the docks, coaling stations, shops, and accommodations needed for the operation of the canal. To commend the adherence to schedule—the promise that boats would go through in 1913, which is now assured—were to repeat the words of appreciation for the efficiency of the canal management already expressed in these pages and so often reiterated in the editorial pages of the daily press. As engineers and constructors, however, the readers of the Engineering Record are better fitted than the public at large to understand what has been accomplished. With this keener appreciation their "well done," given generously, as this journal knows from the expressions that have come from engineers and contractors, will be even more welcome to the workers on the canal than the uniform commendation of the public at large.

What's in an Asphalt's Name? In the article on asphalt cements in the Engineering Record of Sept. 27 Colonel Howard protested vigorously against specification of asphalts by brand name. Just what absurdities and unfairness this may lead to was exemplified recently in a large contract for a road to be built near New York City. The specifications contained a clause that no asphalt cement would be accepted unless it had been on the market under the same brand name for three years. The practical result has been to bar out certain good materials, but at the same time to permit the use of an asphalt which, while under the same brand name for three years, has been made from raw materials from three different sources. To draw up specifications permitting the use of "Stickum" because it has been on the market for the last three years, although in that time made out of three different materials—to do this while excluding products of better known source and composition on the ground that they have not been in use for three years under a brand name is to do injustice, from which consumers as well as manufacturers may be sufferers. The use of such a clause indicates either ignorance of the conditions in the industry—and thus lack of competence to write specifications—or a desire to limit competition. Either horn of the dilemma is an unpleasant one for an engineer to be caught on.

New Niagara Falls Turbines The new turbines of the Niagara Falls Power Company, described on page 443, are noted particularly because they were designed independently of the turbine manufacturers and were built by a contractor, the Bethlehem Steel Company, without experience in turbine work. It is stated that a considerable saving was thereby effected. While this procedure is the customary one in most lines of engineering, it has not often been followed in the wheel end of hydroelectric plants. It has—rightfully, too—been assumed that most of the valuable experience in turbine work was in the organizations of turbine manufacturers. It was logical, therefore, to utilize their experience as far as possible, trusting to competition among manufacturers to bring the price down to a reasonable minimum. That the latter result has not always been obtained hydraulic engineers well know, the eloquence of the sales and technical staffs of the manufacturers sometimes carrying the day for a design well loaded up—at least, from the standpoint of the holder of a pound-price contract. The arguments for an independent consulting engineer are the same in turbine design as in any other engineering work. The ability of financially strong manufacturers to enter into a bonus and penalty-clause contract is urged with good reason in favor of contractor's designs, but, as in other cases, the answer must be that one's consulting engineer must be well selected. In the case of machines of unusual character the advantages of competing contractors' designs are obvious, for they have probably spent thousands of dollars in obtaining experimentally information to which the consulting engineer has no access, but even then good practice demands that a competent consulting engineer be called in to check and approve the designs. He will be able in most cases to save far more than his fee.

A Practical Idealist It is with deep regret that the whole engineering world has heard of the death of Dr. Rudolph Diesel, inventor and developer of the engine which bears his name. While he lived to see his work acclaimed a great success by his professional brethren, further developments in the perfection of his engine were confidently looked for by those who knew him well. While he might not himself have admitted it, he was an idealist, not after the fashion of those who dream idly, but of those whose plans are all designed to the attainment of one great object. In his student days he became imbued with the ambition of discovering a prime mover of higher thermal efficiency than any then in use. To this star he hitched his wagon and through years of patient study and still more patient experimentation kept his attention steadfastly directed toward the great idea. Though graduated, in 1879, at the age of 21, from the Munich Technical College, it was not until 1893 that the profession was apprised of his studies. Then came the laborious years of experimentation, backed, fortunately, by the great resources of the Krupps and the Maschinenfabrik Augsburg-Nurnberg, resulting finally in 1898 in the first commercially practicable Diesel engine. Further developments appeared almost yearly—in improvements in stationary types and extension into the field of marine work. Engines of 1000 and 1200 hp have been built, while experiments on single cylinders of 1000 to 2000 hp are under way. Commercially the type has long been on a firm basis in Europe, though its manufacture here can scarcely be said to be in its infancy. Through technical literature, however, American engineers have long been acquainted with the engine and its merits. For that reason the regret at Dr. Diesel's death will be as great here as abroad—and it is not amiss in this word of tribute to emphasize again the impelling motive of his professional life—a single great idea.

What Highway Systems Cost So much is heard about the excellence of roads in England and France that occasionally some consideration of their cost is helpful to a fuller appreciation of what will be necessary in order that systems of equal merit (traffic requirements being considered) may be developed here. A good presentation of the situation will be found in the paper by Colonel Sohier in the last issue of the Engineering Record. He points out that the road mileage of France is 371,000 and that the cost, at a time when wages were very, very low, was $1,663,000,000. On this basis, to secure a system for the 23,000 miles of highways in Massachusetts would require the expenditure of $100,000,000. Moreover, France spends $45,000,000 per annum for maintenance. This is about $120 a mile a year, a figure which, of course, as an average means very little, since on the main roads a much greater amount is spent, and on the minor roads considerably less. The Minister of Public Works, too, is recommending that $50,000,000 additional be provided during the next 10 or 12 years for some bituminous binder on 6000 miles of national highways, where it is greatly needed. Turning now to England, where, in Colonel Sohier's opinion, the road surfaces are, on the whole, better than those in France, it is found that the average cost of maintenance on the 27,800 miles of main roads in England and Wales is $475 per mile per annum, and that on the 95,000 miles of rural roads in England the average cost of maintenance is $115. It should not be forgotten, too, that wages are lower there than here. While these figures should not—and in fact will not—discourage persistent effort to improve highway systems here, they may well be borne in mind to silence those who see little good in our own works and much good abroad. True it is that in some sections of the country appropriations for a few selected routes have compared well with those quoted, but taking the country generally the amounts available have been pitiably small as compared to English and French practice.

Traveling Sewage Distributors Several departures from present practice in treating sewage of American cities characterize the designs of the plant at Springfield, Mo., which Mr. Alexander Potter described last week at the convention of the American Society of Municipal Improvements in Wilmington. An abstract of the paper is printed on page 440. The works are claimed to be the first in the United States to employ on a large scale the English method of distributing sewage over stone filters by means of travelers, drawn back and forth over long, rectangular beds by an endless cable. This plan of distribution is so radically different from that of the sprinkling nozzles, which have been used so generally in the United States, that a comparison of the results obtained by the two methods will be of great interest to sanitary engineers; as yet no such comparative data are available. It is generally conceded that sewage can be applied to filters more uniformly by the power-driven mechanical distributor than by the spouting nozzle; but in this country, at least, it has been held that severe winter weather would soon put any form of moving apparatus out of commission. Unfortunately the Springfield plant has not been in operation long enough to enable a reliable estimate of its cold-weather performance to be formed. The designer of the plant, however, has realized that the travelers may freeze up and has made provision for operating his filters as contact beds in case of emergency. In discussing this matter of cold weather in its relation to the operation of sewage-treatment plants it is interesting to note the testimony of Mr. Macallum, city engineer of Hamilton, Ont., to the effect that the revolving distributors at Lethbridge, Alberta, have been run during a Canadian winter on open beds. While the distributors at Springfield are the chief novelty of the plant, the concrete settling tanks are unusual. They are clover-shape in plan, with interior tie rods incased in concrete, and are of the two-compartment type, with special provision for increasing the settling efficiency by inducing vertical circulation. The plant must be regarded as a pioneer in certain of its features and as such its operation should prove an interesting study.

Clay-Hole Dumps for Chicago's Garbage

Asking that the people of Chicago "hold their horses and give the administration a chance" to get out of the garbage disposal muddle, Mayor Harrison recently explained that one of the greatest difficulties encountered has been to find a suitable location. No one part of the city, he declared, wants to be made the backyard for the remainder of the community. The mayor states that eventually he favors three reduction plants, and also that the filling of clay holes for the present "is better than to submit to being held up by a company which has already taken $600,000 in profits from a plant that originally cost it only $250,000 at the most, and demands $475,000 for it now."

As noted in the Current News Section of this journal last week, the present predicament was brought about by the expiration of the contract with the reduction company on Sept. 30, and the failure of an appraisal board to agree unanimously on a purchase price. Procrastinating until the month previous to the expiration of the contract before appointing such a board, and then expecting three conscientious engineers to take "snap judgment" is treatment too often accorded members of the engineering profession by lay officials.

Why this matter was not settled months ago and the second city in the country spared the humiliation of returning to archaic clay-hole dumping seems inconceivable in this age of progressive sanitary science. It is not often that garbage has the honor, or dishonor, of a front-page headline, but the wastes of Chicago achieved that distinction when the end of the month rolled around and the unemptied pail at the kitchen door began to attract attention in no uncertain manner. Special calls for council meetings at 2 o'clock in the morning, crazy proposals of emergency treatment with mysterious patented compounds, untried except experimentally, offers of 10 cents a ton for the garbage to be delivered to a plant to be erected within thirty days, militant seizing of the old plant, or simple dumping of the disagreeable decaying matter into the clay holes—all received prominent newspaper publicity. Meanwhile a city waste commission, appointed months ago by the city council to study the whole situation, could not engage the engineers it desired because the $10,000 appropriation, supplementing the commission's appointment, lacked the mayor's sanction. Within the last few days, however, this ordinance has become effective without his signature. The temporary aspects of the situation will not be studied by the commission, except insofar as they bear on the permanent solution. The Health Department is engaged in solving the emergency dilemma.

Though the problem has been before the city officials for two years never has a comprehensive study been made, although the local press, this journal, and commercial associations have repeatedly called attention to the dire need for an exhaustive survey by qualified engineers. The condition in which the city finds itself is a disgrace to a progressive municipality. It is high time that politics be eliminated from the Chicago garbage question and a scientific solution of the problem be found and carried into effect without the restraining influence of political wire-pullers.

Economics of Factory Lighting

In the anti-waste campaigns which are being conducted by managers of industrial plants in many localities the economics of illumination often receive scanty consideration. Ventilation, cleanliness, devices for safer machine operation and improved sanitary equipment are accepted by progressive factory executives with small hesitation when proposed by experts upon production, provided the establishment in question can afford such betterments. Too frequently the connection between adequate illumination and output is overlooked or else neglected because the first cost of a suitable lighting installation seems to be an outlay without an assured return. On the other side of the Atlantic a different view of this matter is taken and it is time that more industrial plants in America realized the true situation, which was well brought out in a paper on "Factory Lighting" by Messrs. M. H. Flexner and A. O. Dicker at the recent convention of the Illuminating Engineering Society.

It may be taken for granted that the volume of production in a well-lighted factory will exceed that of the same plant under poor conditions by from 8 to 15 per cent, to say nothing of the benefit to the workman and the decreased liability to accident. The authors assume in a typical case that a 100-watt tungsten lamp is required for each man, and that it burns 3½ hours per day for 300 days per year under the conditions of electric service prevailing in Chicago, which enable the factory owner to purchase electricity for, say, an average yearly rate of 5 cents per kilowatt-hour, with free lamp renewals. Taking the cost of the reflector at $1 and the cost of wiring per outlet at $4, the yearly fixed charges on this investment, with interest at 6 per cent and depreciation at 12½ per cent, amount to only $1. The cost of electricity for the year is then $5, and allowing 3 cents per lamp per month for cleaning, the total yearly expense reaches $6.36, or 0.63 per cent of a yearly wage of $1,000, which is a very small outlay in proportion to the factory labor cost. Looking at this question from another angle, and assuming that adequate lighting in a specific case increases the output only 5 per cent, the authors find that the installation of ninety 250-watt outlets, fixtures and reflectors at a cost of $517.50 in a factory of 30,000 sq. ft. of working floors will be paid for in much less than a year by the increased profit on the augmented output, taking the yearly business under the old regime at $83,333, secured under artificial light and allowing a 20 per cent profit on the increased revenue of $4,166 resulting from the modern installation. In still another instance the cost of light per day, taking all charges into account, came to barely 2 cents per workman, the wage being $3.50. Under such conditions it is nothing less than absurd for a factory owner to spend, as was done in a particular case, $18,000 for a machine to be run by a high-priced operator of long experience, and then to refuse to spend $19 for lighting equipment in order that the work in process need not be taken to a window 20 ft. distant for calipering.

Examples of this kind might be multiplied indefinitely, but it appears that factory owners in not a few instances must be relieved of making the actual initial investment as such before the modernization of their plant lighting can be accomplished. An interesting scheme for taking care of this feature of the problem has lately been started by the Commonwealth Edison Company at Chicago. The factory owner is offered a contract for two years' service, which includes a rental charge, maintenance charge and an electricity charge, the fixture and the wiring becoming the property of the consumer at the end of the period. The rates are moderate per fixture per month and the scheme permits the factory owner who dislikes paying a lump sum for the modernization of his system to meet this cost in installments. In the interests of more efficient service, there is doubtless a field for contracts of this kind; but it is to be hoped that factory executives and owners ultimately will be sufficiently aroused to the value of good lighting, treating the problem of its installation on the same basis that they would handle the question of motive power or internal transportation. The time is coming when governmental authorities, urged by workingmen's organizations, will see to it that decent conditions of illumination prevail in manufacturing plants of every kind, on the ground that the conservation of the eye is as important as any other phase of sanitation. It behooves the easy-going factory manager to anticipate this legitimate demand, which in probably ninety-five cases out of a hundred can be met with ultimate financial profit to the establishment. Engineers and architects can do a vast amount of missionary work along these lines to the great and lasting good of their employers and clients.

Buffalo Terminal Unification

The Buffalo terminal-unification plan, described in this issue and that of last week, was first promulgated in 1904. The scheme was not pushed by the railroads interested, and the New York Central proceeded to develop its Gardenville project to handle all interchange business with foreign roads and all traffic between the New York Central to the east and the Lake Shore and the "Nickel Plate" to the west. This yard, which will probably be larger than any in existence, is half built, and although Mr. Kimball, the proponent of the Lancaster-yard project, ignores it, it cannot seriously be left out of consideration.

Then, too, it is proposed to bring the Canadian group of railroads into the yard via the

International Bridge and the belt lines. As a matter of fact these roads have a natural outlet on the frontier at Suspension Bridge, 25 miles to the north, through direct connection with three of the Eastern trunk lines, and here classification will likely be continued, despite any elaborate unification plan, no matter how meritorious.

Thus the New York Central lines and a large part of the international business are eliminated, little is left, and the entire project has meager chance of realization for generations, if at all.

As to whether so large a yard (35,000 cars) could possibly be operated, opinions differ. The success or failure of the reconstructed Chicago clearing yard will shed some light on the point. Certainly an improvement on the existing interchange facilities in most large railroad centers is much to be desired, and study of the problem should be encouraged. As a study the articles referred to have great value for the terminal engineer and for these reasons merit a place in this journal.

The design of the Buffalo yard seems to be based on one very dubious assumption—that there would be perfect team work among the roads interested. Its proponent advocates requiring inbound trains to be made up with solid groups of cars for foreign lines using the terminal, thus minimizing classification; but such perfect co-operation has probably never been attained even between different division yards of one road. Into the receiving yard would come trains of all lengths—some too long for the 100-car tracks, some requiring much switching, some little or none. The receiving tracks should have variable lengths to fit the tonnages of the different roads as far as possible, though there would, necessarily, be much surplus trackage for emergencies.

The idea of large forwarding yards is a good one, imposing the responsibility for delays on the outgoing road. The size here is probably overdone. The subdivision of the repair yards into receiving, repair and advance units is commendable, although the locations of the latter make the getting out of cars difficult. A good feature of the layout is the elimination of turntables and conflicting movements from the paths of the locomotives, such an arrangement being possible only with a very large yard.

The scheme of classification units has many serious defects. As proposed, each of the two hump tracks in one direction is to serve sixty-five classification tracks. These are arranged in the form of eighteen body tracks, parallel with the main yard and crossed by four ladders with slip switches, thus dividing the yard into five sections. The outside tracks of each group and others necessitated by the subdivisions of the yard among the various roads would be kept open as thoroughfares. In this way "perfect flexibility" is aimed at, the reassignment of yard sections and thoroughfares being made as traffic necessities would dictate.

Careful study of this design raises many doubts, however, as to its feasibility. To begin with, successful practice has shown thirty tracks to be about the limit for one hump track. Furthermore, if thoroughfares are to remain such they must not be flexible at all, but must be physically apart from the classification groups. Then, in order to keep cars moving to the last group, the whole yard must be on a heavy grade, and it would be almost impossible to stop them where desired. On account of the overlapping groups the car riders would be hampered in getting to the trolley tracks readily, and many riders would be required. The classification tracks are far too short, both for safety and capacity. They would be cleared, apparently, by letting them out on the ladder used to let cars into the group beyond. There could hardly be adequate interlocking protection, and collisions would occur constantly. From a maintenance standpoint, moreover, the multiplicity of slip switches would require an army of laborers, and in a busy railroad yard there is no room for an army.

Should the attempt be made to work sixty-five classifications from one hump track some provision for reclassification for the various roads would inevitably be necessary, either by auxiliary humps or by tail switching.

Valuable though the project is as a terminal study, it is certain that the details need material alteration; while the railroad situation at Buffalo, no matter how desirable unification is—and it certainly is, theoretically, a move in the right direction—makes the plan impossible of realization.

Liquid Fuel and Ship Propulsion

Among the developments in combustion engineering which are of large present interest is the increasing use of fuel oil in ship propulsion. In both technical and lay circles the subject is attracting much attention. The "Transactions" of the Institute of Marine Engineers for August contain a paper upon this topic by Mr. C. Zulver, which, with the appended discussion, occupies some sixty pages and sets forth the status of current fuel oil practice in the marine field in a comprehensive manner. On the popular side, the question is effectively treated in the October issue of the American "Review of Reviews" by Mr. Lewis R. Freeman. The student of motive power will find much of interest in each of these presentations.

The engineering advantages of fuel oil for marine service as contrasted with coal are generally appreciated by naval architects of the first rank. The adoption of oil in the British Navy as its standard for the immediate future for new ships and the provision of oil-burning facilities on every United States battleship laid down within the past six or seven years are sufficient evidence of the practicability of liquid fuel to dispel a vast amount of scepticism on the part of advocates of coal. The limitations of oil, so far as its use in the generation of steam is concerned, are mainly those of supply and consequent price, while its use in internal combustion engines, as recorded in these pages, is most promising, whether on the direct drive or the Diesel-electric system.

Regardless of the type of prime mover used, Mr. Zulver shows that within wide limits of cost, fuel oil has many important advantages over coal. For equal weights oil contains about 25 per cent more heat units than first-class coal; liquid fuel can be stored where coal cannot be carried, as in double bottoms; bunkering can be carried out quickly and without disturbance to the loading or unloading of passengers, and trimming, indispensable with coal, is eliminated. Moreover, a closer control can be maintained over steam production, which insures more even speed, enhanced boiler efficiency and reduced boiler wear and tear, on account of the maintenance of uniform temperatures and closed fire doors. Skilled firemen, too, can be dispensed with. From a number of voyages of the same ship, with the boilers burning coal and oil at different times and the engines kept running as nearly as possible in the same condition as regards vacuum, revolutions, etc., Mr. Zulver found that with a dead-weight carrying capacity of 7700 tons, the consumption of oil works out over a series of years on the steamer Conch at about 22.5 tons per day against 32.5 tons of Welsh coal, and that, too, with a gain in average speed of about 1.5 knots when using oil. In passing through tropical waters the use of oil fuel with mechanical firing is a factor in speed maintenance on account of humanitarian considerations, and, moreover, as one fireman can easily attend to eighteen furnaces, the benefits of oil fuel are by no means confined to the heated belts of the globe, when considered from the standpoint of labor cost.

The fire hazard is more important at sea than anywhere else, outside of an aeroplane or a dirigible, and it is noteworthy that those discussing the Zulver paper at the institute meeting in general agreed with the author that with due care there is no more danger in using liquid fuel than in burning coal. The former, unlike the latter, does not deteriorate to any extent in calorific value while stored, and is not subject to the hazards of spontaneous combustion. The measure of safety in the use of oil for ship service is largely dependent on the flash point of the oil, which should not be less than 150 deg. Fahr., unless special precautions are taken in the shape of separate oil and gas-tight compartments for pumps, heaters, filters, etc., with insistence upon skilled attendance.

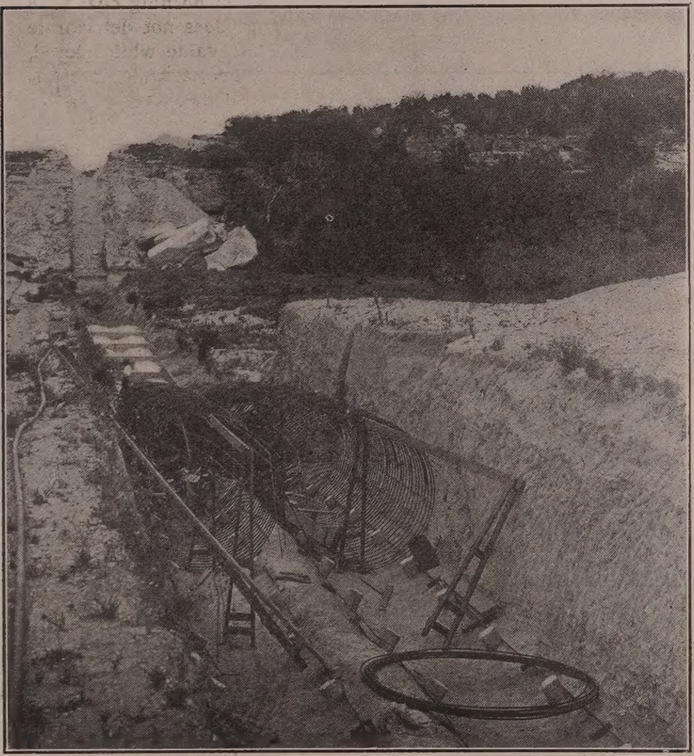
From the commercial standpoint, the development of the motor vessel directly driven by an internal-combustion engine is of much significance, and has gone far beyond the experimental stage. Using Diesel engines, it has been found that an increase of from 12 to 17 per cent in dead-weight carrying capacity can be secured, while size for size, the liquid fuel tank will take a vessel five times as far as the coal bunker. The Diesel motor-vessel Vulcanus and the steamship Sabine Rickmers, of 2080 and 2290 tons displacement, respectively, each having a mean speed of 8 knots, and being comparable in the opinion of Mr. Zulver, show a fuel consumption of 2 tons of oil and 11 tons of coal respectively on a daily basis, while the former vessel requires scarcely more than half the crew of the latter. Space will not permit discussing the detailed comparisons which enrich the paper, other than to point out that the use of internal-combustion engines enabled the Vulcanus to travel 10,750 miles, or nearly half the distance around the earth with one filling of her oil tanks, and that in covering voyages totalling about 50,000 miles, her cargo capacity is estimated to be 12 to 15 per cent greater than would be possible on a steamer of like dimensions, representing an additional earning power of about $10,500 per annum through decrease in fuel storage space and stokers' quarters, and accompanying space economies. The practical value of making long voyages on a single filling of oil tanks can easily be realized in its relation to the concentration of fuel oil depots in various parts of the world. Up to the present writing, the internal-combustion engine has not been produced in sizes comparable with the modern high-powered steam turbine, but it is expected that at least two vessels of 10,000 tons rating will be in the transatlantic service in 1914, and if the fuel oil supply and its conservation do not disappoint the engineering world, the next decade is likely to see some intensely interesting rivalry between the steam turbine and the internal-combustion engine for the propulsion of ships.

Main Canal of Medina Irrigation Project

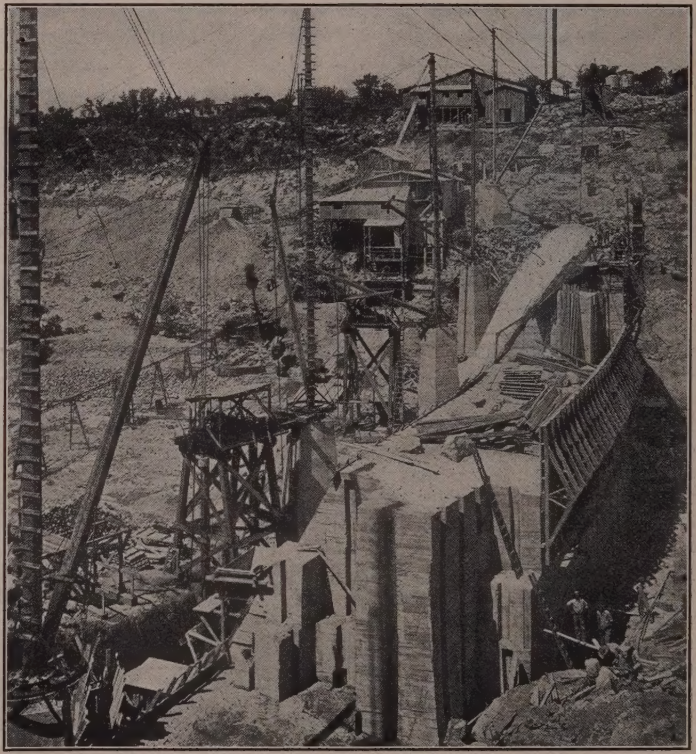
Two River Crossings Are Effected by Reinforced-Concrete Inverted Siphons and a Drop Made by Concrete-Lined Chute

In the 24 miles of main canal carrying 600 sec.-ft. of water from the diversion dam of the Medina Irrigation Company's project, 25 miles west of San Antonio, Tex., to the 60,000 acres of land to be served there are two river crossings, eleven metal flumes, ½ mile of lined canal section, several drops, a wasteway, a concrete chute and at the end a combined notched weir, diversion point and drop. The storage and diversion dams were described in the Engineering Record of Dec. 7, 1912, page 632, and the main canal was briefly noted. Lateral systems have since been completed for 14,000 acres of land.

Leaving the reinforced-concrete intake structure at the west end of the diversion dam through five 5 x 7-ft. sluice gates, the water enters a short section of canal in lined rock section having a capacity of 850 sec.-ft.; but for the greater part of its length it is intended to carry only 600 sec.-ft. In general the canal is constructed on the west side of the river and is located so that the cuts approximately balance the fills.



Construction View of Siphon 2 Looking Downstream



Diversion Dam with Elevated Derricks for Concreting

SIPHONS

To avoid rough country on the west side about 1 mile below the diversion and also to cut off a U-shaped bend the line crosses and recrosses the Medina River by reinforced-concrete inverted siphons consisting of twin tubes 8 ft. in diameter at the first crossing, which is 1150 ft. long, and 7 ft. in diameter at the second crossing, which is 1310 ft. long.

The thickness of the siphon shells varies from 12 in., as shown in the accompanying drawing, for pressures from 60 to 70 ft. to 10 in. for 50 to 60-ft. heads, and 6 in. for all heads under 50 ft. The spacing of the rings making up the transverse reinforcing varies from ¾-in. bars 6 in. center to center to ⅝-in. bars 12 in. center to center.

A base block was laid first of 1:3:5 concrete and the inner wooden forms were set on top of blocks cast in two rows over the base. Square wooden forms with a slight batter were used at first for these pedestals, but later corrugated powder cans with the bottoms knocked out and the sides slightly crushed into an ellipse were found more satisfactory. The conduit shell proper is of 1:2:4 concrete, which was placed quite wet on forms over the haunches and over the central rib.

Wooden horses with notches at the proper spacing were used to support the reinforcing rings. The ends of the reinforcing rings were wired together for ease of handling. A great deal of trouble was encountered in bending the twisted steel, due to its cutting the bender jaws and to its untwisting. In consequence round bars were placed in the latter part of the work.

Although the river bed was ordinarily dry, water from a rainstorm flooded the trench for siphon 1 just after it was opened. Two Van Wie centrifugal pumps were installed and connected to an Avery traction engine.

No provision was made against floods undermining the conduits in the river bed other than the 2-ft. cover, inasmuch as practically all storm water will be intercepted by the storage and diversion dams. The reinforcing is, therefore, placed entirely on the outside of the shell for internal pressure only.

Concrete for the siphons was mixed in ½-yd. Chicago mixers. Both mixers were mounted and moved along the trench on the excavated material at such an elevation that the concrete could be deposited by the chutes directly into the forms.

To insure plenty of water for crystallization of the cement a 2-in. pipe line was laid the whole length of each siphon, with hose connections at intervals of about 100 ft. Burlap was placed over the green concrete for a few days and then earth was thrown on to hold the water, which was applied at frequent intervals for ten days.

Suitable flares to reduce the loss of head were built at inlets and outlets. Stop plank grooves were provided so that one conduit can be closed for repairs if necessary. Below the outlet of siphon 2 is a wasteway leading back into the river. Both wasteway and run of the canal are controlled by hand-operated wooden gates, as shown in the photograph. To catch the sand there is a 14 x 30-ft. depression in the canal floor 4½ ft. deep, sloping toward the waste gates.

The outlet leg of siphon 2 is laid up a 45-deg. slope, and to support it steps were cut in the rock. The conduit was cast in 36-ft. sections with butt joints, and was covered by a 12-in. collar of concrete deposited two days after both sections had been placed.

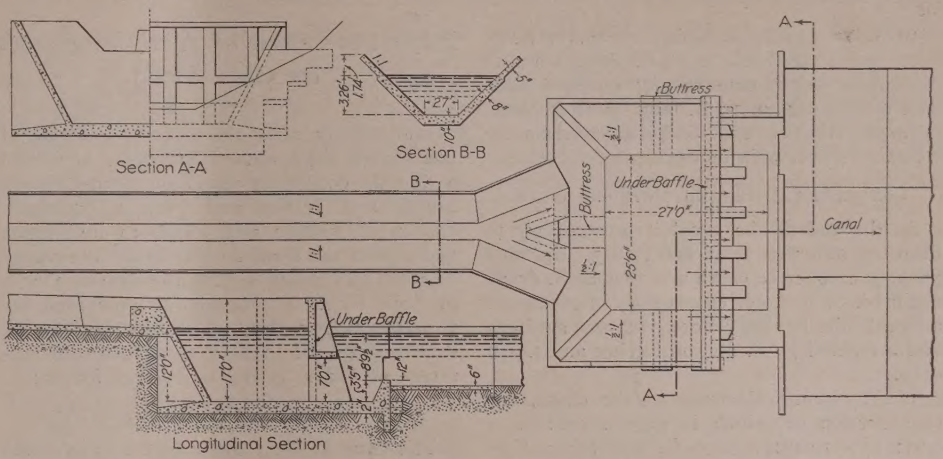
At eleven points in the canal No. 180 Hess flumes, made of Toncan metal, are carried across ravines on creosoted long-leaf yellow-pine trestles. The total length is 5540 ft., the sections varying from 122 to 1522 ft.; while the highest one is carried at an elevation of 95 ft. above ground.

Approaches and exits for the twin 114-in. semicircular sections are formed of the same gage metal and backed up with clay puddle. The cutwater in the inlets are braced with angle irons. Joints for the flared surfaces were riveted in the field, first painting the surfaces with fiber cement.

The hydraulic elements of twin flume 11, the longest one used, are: $r = 2.25$; $A = 31.25$; $s = 0.022$ ft. per 1000; $V = 9.6$ ft. per second; $Q = 300$ sec.-ft., and $n = 0.012$.

LINING THE CANAL

For the greater part of its length the canal is in earth and generally unlined. For 2390 ft. below the intake at the diversion dam it is lined and is located on a hillside, with a side slope of about 3 to 1. The material is limestone, with pockets of disintegrated limestone and adobe, the ground surface being covered



Plan and Section Showing Details of Settling Chamber at End of Canal

with a layer of broken stone and débris. To keep down excavation costs the contractor "shot" the rock heavily, necessitating the use of a large amount of rubble backfill.

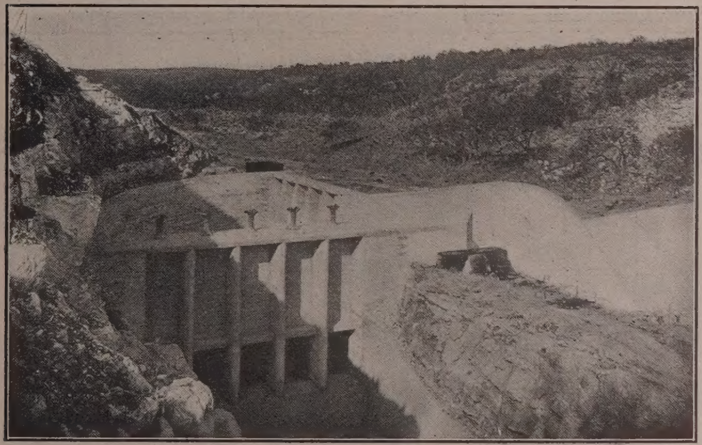
The 850-sec.-ft. rock section is finished 6 ft. wide on the bottom. It is 9 ft. deep, has 1 to 1 side slopes and a 10-ft. top width of bank on the lower side, the outer slope being 1½ to 1. For the section carrying 600 sec.-ft. all dimensions are the same, except the depth, which is 7.3 ft. A free board of 18 in. is provided.

Hand-mixed concrete was deposited in the floor first and then frames were set for the side slopes, the 16-ft. lagging being placed behind them as the sides were built up. No plastering was done except to fill local voids. Expansion cracks have appeared as expected at the ends of the 16-ft. sections.

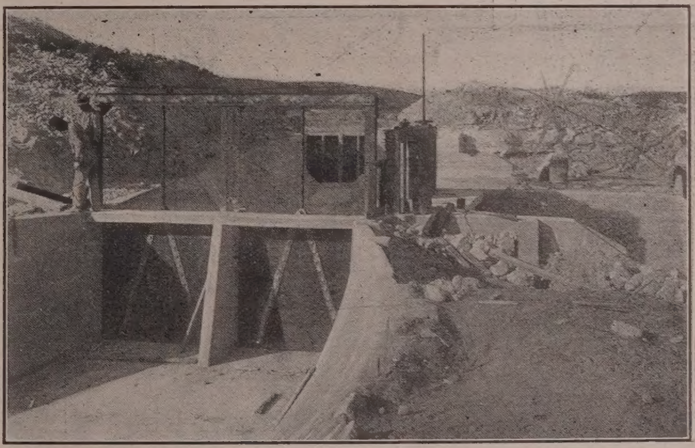
Cost per Lineal Foot of Canal

	Approximate actual cost		Contract price
Excavation	$7.86		$10.56
Rubble	1.56	19 cents per square foot	.86
Concrete	3.11		3.27
Cement	1.80		1.80
Total	$14.33		$16.49

The contract prices were 90 cents per cubic yard for rock excavation, $6 per cubic yard for concrete and $1.50 per cubic yard for dry-laid rubble. The costs per lineal foot of canal are given in the foregoing table.

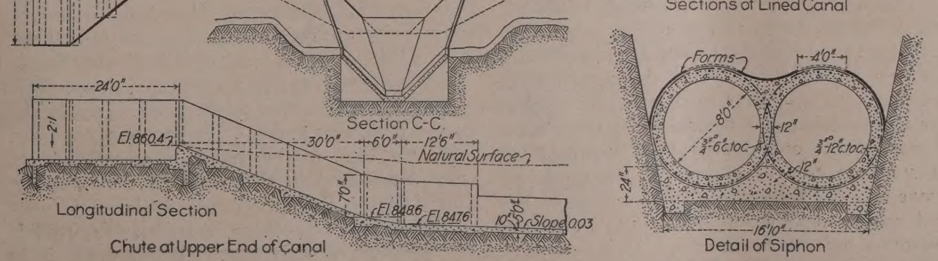


Diversion Headworks of Medina Irrigation Canal



Waste Gate Structure at Outlet of Siphon 2

Cement is figured at $2.40 per barrel at the point on the railroad nearest the work. The common laborers were Mexicans, who were paid at the rate of $1.50 and $1.75 per ten-hour day.



Details of Siphons and Sections of Lined Portions of Canal

The typical earth section 1, on approximately level ground, is 9 ft. deep, has a 20-ft. bottom width, 2 to 1 inner and 1½ to 1 outer slopes and 10-ft. top width of bank. Type 2, on slightly sloping ground, has a 15-ft. bottom width and is 9.8 ft. deep. The other dimensions are the same as in type 1. Furrows paralleling the canal were plowed at intervals of about 4 ft. before building the banks, and for the second section a surface ditch was carried parallel with the upper bank and 10 ft. from it to suitable crossings or inlets. For type 3, all in cut, the bottom width is 18 ft.; the greatest depth was 34 ft., and the side slopes, 1½ to 1. A 10-ft. berm is left at the natural surface. For the latter section a drag line was used, but for most of the excavation, which was largely clay, four-horse Fresnos were employed.

At most points 18-in. double-strength vitrified pipes carry the surface water under the canal, but at a few places double-box culverts of reinforced concrete were built.

Flared concrete head walls with cut-off walls, 18 in. deep at the inlet and 30 in. at the outlet, protect the ends of the pipe, while seepage along the line is guarded against by two collars in the lower bank and one under the upper bank of the canal.

The culverts are 7 ft. square in section, have 10-in. outside walls and a 15-in. partition wall. The top and bottom slabs are 15 in. thick. In each bank are two collars, 12 in. thick, extended 2 ft. outward around the outside of the culvert. The floor of the flared inlet is riprapped back of the cut-off wall, which is a 10 x 51-in. slab, placed vertically between the ends of the wing walls.

DROPS

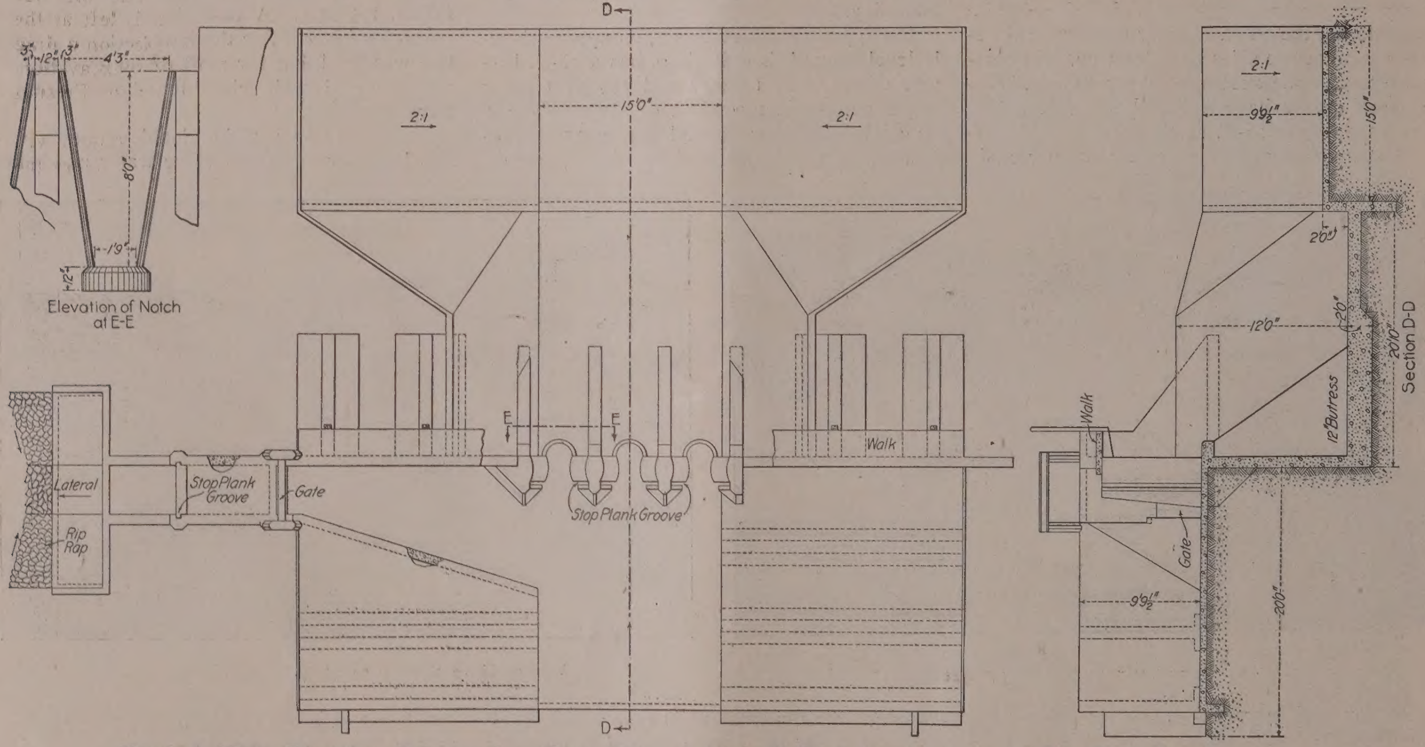
At the head of canal A2, which is fed by A1, is a combined gate and drop, a creosoted yellow-pine structure resting on mud sills laid on puddle. The 6 x 7-ft. wooden gate is made of 6 x 6-in. timbers and is of the same type as that shown in one of the illustrations. The difference in elevation between the two canal bottoms is 3 ft. 9½ in., but the flared outlet has a water cushion 11 ft. 10 in. wide and 2 ft. 3 in. deep, with no water flowing. Entering the gate, the water passes through an inlet flared on the upstream only. Beyond the inlet and outlet the banks are riprapped.

In Lime Creek, in which the main canal runs for 3900 ft., is a 10-ft. drop built of creosoted yellow pine resting on mud sills. The water cushion, 19 ft. long by 22 ft. wide, is lined with 4 x 12-in. timbers spaced on 16-in. centers over 2 ft. of riprap.

Concrete Chute and Notched Weir

At the end of the canal it is necessary to drop the water from El. 860 to 815. For this purpose a concrete chute and two 10-ft. drops are used. The water enters the chute through a flared inlet having concrete warped surfaces and a tapered 30-ft. section having an 11.8-ft. drop.

The hydraulic elements of the chute, the cross-section of which is shown, are: $r = 1.63$; $A = 19.43$; $s = 30$ ft. per 1000; $V = 30.7$ ft. per second; $Q = 596.5$ sec.-ft., and $n = 0.012$.



Notched Weir, Diversion Point and 10-Foot Drop at End of West Canal of the Medina Irrigation Project

At the end of the chute the section widens and a concrete cut-water throws the current toward the outside of the stilling chamber, which has an underbaffle at the lower end heavily buttressed to resist the shock of the water. One of the line drawings shows the details.

About 300 ft. below the stilling chamber are three notched concrete weirs designed to keep up the head of water for the purpose of diversion to the first lateral taken out of the main canal. The weir edges are rounded in the concrete so as to pass the maximum amount of water when the head rises, and stop-plank grooves are provided to maintain a head practically constant at low rates of flow.

With the exception of the flume erection, which was done by force account, the canal and structures were built by Messrs. Roach, Stansell & Crane, the contractors.

The project was organized and financed by Dr. F. S. Pearson, of New York, associated with Mr. H. I. Miller, of New York. The Pearson Engineering Corporation had general supervision of the design and construction. The work was carried out under the direct charge of Mr. C. H. Kearney, chief engineer, and Mr. A. W. Billings. Messrs. J. A. Sargent and B. E. Forbes were the canal engineers.

Report of Board of Army Engineers on Ohio Flood

Immediately after the disastrous floods of last March the Chief of Engineers appointed a board, consisting of Lieutenant-Colonels Shunk and Jervey and Majors Bromwell, Oakes, Altstaetter and Rand, to investigate and report on flood conditions in the valley of the Ohio River and in the drainage area of Lake Erie. The board has now rendered a preliminary report, which has been transmitted by the Chief of Engineers to the Secretary of War. Its main features follow:

Summary of Report

The extreme high water in the Ohio River has been very harmful to all structures and appliances erected by the United States and by private parties for purposes of navigation, and has caused great damage to contractors or to the Government itself during the construction of dams and other works of improvement. At times it has stopped practically all navigation because of lack of head room under bridges or because the swift currents or floating débris made it unsafe to venture from shore. As floods in any of its tributaries affect the Ohio River, a complete study of floods throughout its basin should be made in the interests of our navigation.

One of the most serious effects of the floods was the interference with interstate commerce by the destruction of railroad bridges and damage to roadbeds in the flood plains of the rivers. Cities have been isolated by the interruption of all railroad, telephone, and telegraph lines, and in places famine has been narrowly averted. It would appear that the first requisite for the prevention of interference with interstate commerce, and indeed for the protection of the railroads themselves, should be the exercise by some central body of supreme control of bridges and their approaches. This control should extend to city and county bridges, of which numbers were destroyed by the flood.

While the flood in many places was the worst on record, there is no reason why even worse ones may not be expected in future. If the heaviest of the recent rainfall had been entirely in the Ohio Basin, or if the precipitation had occurred with snow on the ground and surface of the earth frozen, the run-off into the Ohio would have been greater and more sudden and the results even more disastrous. The only factors of severe floods present in this instance were heavy rainfall and obstructed channels. It is not improbable that there have been equal precipitations in the past. The reason why like results were not produced is that the drainage channels were in better condition in the past than they are at present.

The board finds that the damages caused by these floods may be divided into two well-marked classes, those due to high water and those due to strong currents. Damages of the first class to some extent and those of the second class to a very large extent were caused by artificial contractions of the river channels and their adjacent flood plains. Building lines have been pushed forward into the streams, bridge abutments have been used instead of through bridges at proper elevations.

Reservoirs

The board is at present not prepared to recommend means of preventing the occurrence of high stages in the rivers due to excessive rainfall. The method of prevention or reduction of flood heights by the use of storage reservoirs has been considered as well as time allowed and sites for such reservoirs have been looked for in the course of our observations. There are in Ohio three reservoirs having total storage of 7,220,000,000 cu. ft. A site for another has been found near Kenton, Ohio, at the headwaters of the Scioto River, where there is a reclaimed marsh having an area of about 30 sq. miles, lying in the midst of higher ground. It happens, however, that the land in the marsh is as valuable as any farm land in the State of Ohio, selling for $200 or more an acre. Its cost, if condemned, would probably be such as to prohibit a reservoir at this site. Furthermore, it is probable that the use of the land for agricultural purposes is more profitable than its use as a reservoir site would be, since the effect of the reservoir would be local and limited. Strong local opposition may also be counted upon. There are other possible reservoir sites in the district examined, but it is believed that similar objections would be found to them. The board thinks that the prospects for reservoir sites in other parts of the Ohio Basin—Pennsylvania, West Virginia, and Kentucky—are better, and recommends that further investigation be made.

The board then describes briefly the work contemplated at Columbus, and states that, although this work will probably result in the protection of Columbus from floods, it may be that conditions below the city may be made worse as the delivery of water to the lower reaches will be facilitated, and unless a means of escape be provided the flood will be to some extent merely transferred from one point to another. This indicates the necessity of adopting a comprehensive plan for the Scioto Valley, to which plan the special projects for the various towns must be accommodated. It therefore appears that the problem is a far more than local one.

Columbus, Dayton, and Hamilton have provided for such surveys as are necessary for their own particular purposes, but so far as the board knows no comprehensive survey is being made that includes all of the information necessary for solving the problem of flood control of any stream in the Ohio River Basin. Many partial surveys have been made, but very few complete surveys have been made including all the data necessary for the determination of all questions of river control.

As to its further operations, the board is of opinion that, in accordance with its instructions, the whole subject of floods and their prevention should be fully investigated, since this is a matter which vitally concerns navigation and interstate commerce. The board recommends that the work of collecting information and formulating a plan of procedure with estimates of cost be intrusted to the Pittsburgh office.

DIVIDED CONTROL OF WATERCOURSES

The board has been much impressed in its examination by the evils of divided control of the watercourses. The obstructions which have been placed along the various streams ought never to have been put there and their construction should have been prevented, but since the control of rivers is in the twilight zone between the spheres of Federal and State authority, it developed that what was anybody's business was nobody's business, and no effective authority has been exercised by anybody. These rivers are feeders of a navigable stream and have an important effect upon the regimen of the Ohio River, and it is the opinion of the board that the authority of the United States should be exercised to prevent encroachments upon them exactly as in the case of navigable streams. It is believed that this is the only method of control which promises good results in practice. The board further urges that immediate steps be taken to exercise such authority, since bridges and other structures are to be rebuilt at once, and there is evident danger in several places that they may be rebuilt in an obstructive manner.

In transmitting the report to the Secretary of War, the Chief of Engineers says in a general résumé:

"Referring to the remarks of the board concerning the possibilities of help from reservoirs, there is not sufficient data at present in this office to justify a satisfactory estimate of the extent of such a system. A recent report indicates that a system for the partial correction of the flood situation on the rivers above Pittsburgh alone would cost about $34,000,000. Even if a complete system were technically practicable for the entire Ohio Valley, some idea of its probable magnitude may be gained from the fact that the area of the Ohio Valley is 204,320 sq. miles, of which 57,623 sq. miles are contributed by the Tennessee and Cumberland Rivers, which enter into the Ohio near its mouth, while the drainage area of the rivers above Pittsburgh just referred to is but 10,152 sq. miles, or 5 per cent of the whole. It is the present opinion of this office that very little expenditure of money on reservoirs in the Ohio Valley will be found to be justified in the interest of flood prevention alone."

The Chief of Engineers urges, in conclusion, that the work of investigation as recommended by the board be continued.

Street Cleaning in New York in 1912

An idea of the comprehensive organization needed to care for the cleaning of New York City's streets may be obtained from the report for 1912 of Mr. William H. Edwards, commissioner of street cleaning. The authority of his department extends to Manhattan, the Bronx and Brooklyn.

The area requiring cleaning is grouped in Table 1 according to type of paving and locality.

TABLE 1—TYPE AND LOCATION OF PAVEMENTS, DEC. 31, 1912

	Manhattan		The Bronx		Brooklyn			Total	
Kind	Sq. yd.	Per cent	Sq. yd.	Per cent	Sq. yd.	Gutters, Sq. yd.	Per cent	Sq. yd.	Per cent
Sheet Asphalt	4,951,979	53.8	1,062,130	28.3	8,536,563	....	63.3	14.550,672	55.0
Asphalt Block	1,264,347	13.7	1,349,796	36.0	590,314	....	4.4	3,204,457	12.1
Granite Block	2,134,152	23.3	1,029,987	27.5	3,192,359	193,726	25.1	6,559,224	24.8
Medina Block	2,490	....	3,054	0.1	148,327	....	1.1	154,771	0.6
Belgian Block	314,639	3.4	3,700	0.1	410,694	....	3.0	838,005	3.2
Trap Block					3,252	....	0.0		
Cobble					103,720	....	0.8		
Brick	....	....	6,282	0.2	45,500	37,520	0.6	89,302	0.3
Wood Block	536,127	5.8	121,094	3.2	126,313	....	0.9	783,534	3.0
Iron Slag	....	....	31,807	0.9	62,960	....	0.5	94,767	0.3
Concrete Macadam	....	....	....	...	400	44,189	0.3	44,589	0.2
Bituminous	....	....	137,232	3.7	....	....	...	137,232	0.5
	9,212,734		3,745,982		13,220,402	275,435		26,454,553	

To clean this area 2,974 sweepers (Manhattan, 1,788; The Bronx, 288; Brooklyn, 898) were employed, making the average 8,895 sq. yd. per sweeper for all three boroughs, or, singly, Manhattan, 5,153; The Bronx, 13,007, and Brooklyn, 15,029. If the gutter area, which is infrequently cleaned, be deducted, the real average for Brooklyn becomes 14,722 sq. yd. The mechanical apparatus includes 95 sprinkling carts, 148 machine brooms, 5 flushing machines and 9 squeegees. The water-cleaning plant is altogether too small, the commissioner states, requiring the assistance of hose flushing, a method proved ineffective and wasteful in a test in 1910.

The further purchasing of flushing machines is considered unwise by the commissioner because of a decision of the United States Circuit Court stating that any machine "having a flat nozzle capable of delivering the water nearly parallel to the roadway" infringes upon existing patent rights. One of the flushers owned by the department has already been eliminated by this decree.

TABLE 2—STATISTICS RELATING TO STREET CLEANING IN THREE BOROUGHS OF GREATER NEW YORK

	Manhattan	The Bronx	Brooklyn	Total
Population	2,435,711	532,981	1,775,079	4,743,771
Area in Sq. Miles	21.90	41.40	70.80	134.10
Maximum Density of Population, per Acre	1,103.10	140.20	260.80	
Minimum Density of Population, per Acre	36.20	8.10	8.40	
Average Density of Population per Acre	182.10	16.90	40.70	
Miles of Streets..	470.00	450.00	1,040.00	1,960.00
Miles of Paved Streets	439.02	154.92	672.37	1,266.31
Average per Capita Waste in lbs. per Annum:				
Ashes	1,507	699	887	1,184
Rubbish	97	42	91	89
Garbage	157	122	132	144
Total	1,761	863	1,110	1,417

The adverse action of the special committee of the Board of Estimate and Apportionment has prevented the purchase of an adequate number of squeegees, which, the report states, have given excellent results on smooth pavements in other cities. It is deemed expedient to adopt a system soon which shall combine wet and dry machine work, using the hand sweeper for litter and manure collection.

Great difficulty has been encountered in procuring dry sand, and since wet sand does not act well in sand-spreading machines, this part of the plant has not been augmented. However, 1-cu. yd. sand boxes have been placed at steep grades and the public has been asked through the press to use the sand, when the attendants are absent, to prevent accidents to horses.

In 1912 the department handled 2,755,897 tons of ashes and street sweepings, 210,652 tons of rubbish and 340,815 tons of garbage, totalling 3,307,364 tons; 1,150,136 families in 278,207 houses were served. A force of 1970 drivers was employed—1,028 in Manhattan, 208 in The Bronx and 734 in Brooklyn.

The importance of substituting larger carts for those now in use is indicated by the fact that the 5-ton truck requires only twice as long for a round trip, i.e., to gather a full load, carry it to the dumping board, discharge it and return to collection service; but during that round trip it gathers six times as much as one of the smaller carts. In a test it was found that the average time for a small cart was 72 minutes—42 minutes for loading, 25 minutes for hauling, and 5 minutes for dumping; while the truck took 145 minutes—107 minutes for loading, 30 minutes for hauling, and 8 minutes for dumping. Limited tests of motor trucks for this service seem to warrant their use, and the performance of the three ordered for next year will be carefully watched.

Other data appear in Table 2.

Commissioner Edwards intends to establish a bureau of statistics and efficiency on Jan. 1, to the end that more detailed cost data than are now available may be obtained.

A SANITARY DISTRICT, known as the Ruhrverband, to have charge of the Ruhr valley in the same way that the celebrated Emschergenossenschaft controls the sanitary condition of the Emscher valley, has been formed. The matter has been under consideration for some time, Dr. Karl Imhoff serving as chairman of the commission having the matter in hand. Now that the law has gone into effect Dr. Imhoff has been chosen chief engineer. A similar district is under contemplation for the valley of the Wupper River.

Coal-Handling Plants for Panama

Awards have been made, according to the "Canal Record," to the Hunt Construction Company, of New York City, and Augustus Smith, of Bayonne, N. J., for furnishing the equipment for coal-handling plants at Cristobal and Balboa in the Canal Zone. Each plant will consist of two waterfronts and a storage pile. Coal will be received at these plants by movable unloading towers running on rails, some being reloaded on colliers and barges by movable reloaders. The main plant will be at Cristobal, where the storage pile will be commanded by movable stocking and reclaiming bridges running on rails parallel to the longitudinal side walls of the coal basin. Four berm cranes, traveling on rails supported by a suitable concrete-and-steel trestle running longitudinally with the basin, will command the Balboa storage pile.

The unloading towers will be of steel construction, steam-driven, self-contained and self-propelling. Each will travel on two parallel pairs of rails at deck level, on 30-ft. centers at Balboa and 35-ft. centers at Cristobal. Between the pairs of rails will be a 5-ft.-gage track suitably located to receive coal from the tower hopper. The towers will have a minimum speed of travel of 50 ft. per minute. They will have 100-cu. ft. buckets and 30 x 12-ft. receiving hoppers. The tower will mine coal either from vessel or from coal pile, and will deposit it into vessels, storage pile or its own hopper.

The stocking and reclaiming bridges at Cristobal will have two buckets each, of 200-cu. ft. capacity. Berm cranes now at Miraflores will be used at Balboa. Each bridge will be of steel construction throughout, electrically operated and self-propelled. They will be able to stock or reclaim at the rate of 1000 tons per hour.

The reloaders, also of steel construction, electrically operated and self-propelling, will receive coal from the conveying system and deliver it to vessels of variable sizes and arrangement. To accomplish this each reloader is to have a hopper to regulate the flow from the conveying system, a separate conveying system to transfer the coal to the discharge end of the reloader, and an adjustable boom with a telescopic chute to deliver the coal. Each reloader will have a normal rated capacity of 500 tons per hour.

A conveying system, consisting of 10-ton automatic electric cars on a double track, will transport coal within the plant. Each plant will have a wharf bunker about 20 x 100 ft., with a capacity of about 1500 tons, to supply small craft. Weighing devices will be installed which will as far as practicable automatically record net weight of coal.

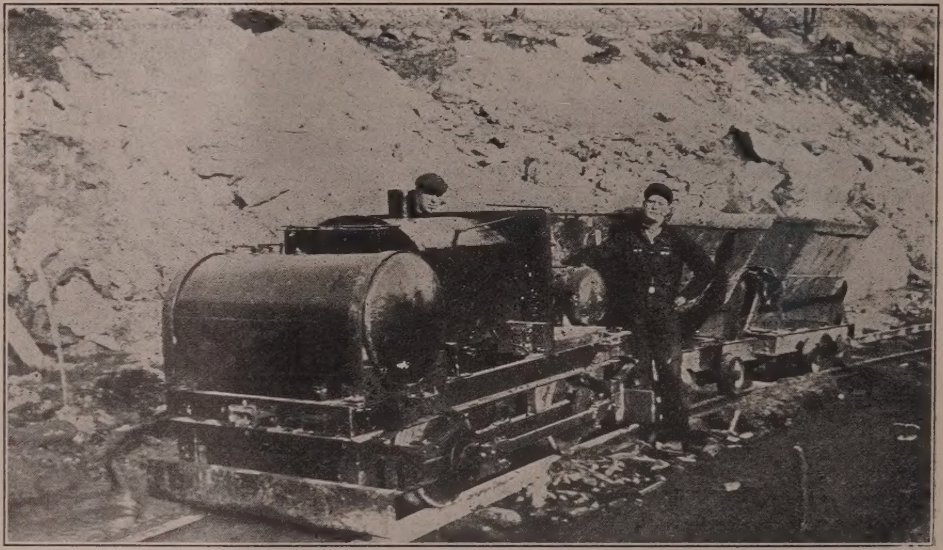
The specifications for the Cristobal plant are based on the following requirements: Wet storage, reserved for naval use, 100,000 tons; dry storage, for canal use, 100,000, and emergency storage, 100,000—a total of 300,000 tons. The corresponding figures for the Balboa plant are as follows: Wet storage, 100,000 tons; dry storage, 80,000, and emergency storage, 30,000—a total of 210,000 tons.

FLIES AT SEWAGE FILTERS are eliminated to a large extent, according to observations of Mr. George E. Datesman, principal assistant engineer of the Bureau of Surveys, Philadelphia, who has recently returned from a European trip of inspection, by building solid inclosing walls around percolating filters and covering the surface of the bed with fine medium.

Concreting the Sarles Tunnel of the Catskill Aqueduct

Many methods of delivering concrete to forms have been tried by the contractors on New York City's Catskill aqueduct. On the northerly end of contract 55, which was awarded to William C. Baxter, there are four tunnels, having an aggregate length of 11,780 ft. The method employed in lining one of them, the Sarles tunnel, 5230 ft. long, involved the use of oil-burning steamer dinkey locomotives for hauling the concrete cars.

The crushing and mixing plant for the tunnel and the 1500 ft. of cut and cover between it and the south portal of the Millwood tunnel was located at the foot of a spoil-bank about 400 ft. from the south portal of the first tunnel and 35 ft. below the grade of the invert. The concrete was dumped from the mixer into an inclined bucket conveyor, which carried it to a bottom-dump hopper near the tunnel portal. From here it was taken as needed by the concrete cars. Three of them, of 32-cu. ft. capacity each, constituted a train and were hauled by a Bell 30-hp oil-burning steamer dinkey locomotive, built so as to travel forward or backward at equal speed. This train ran on a 2-ft.-gage track, which was laid (after the tunnel excavation had been completed and the invert sub-grade shaped up) the full length of the tunnel and slightly to one side of the center line.



Oil-Burning Locomotive Hauling Concrete Cars

In the sequence of operations the invert was laid first. Alternate bays, each 20 ft. long and of one-half the width of the tunnel, were filled with concrete, dumping directly from the cars. After the concrete had set the intervening bays were filled. When one-half of the invert had been completed throughout its length the track was moved to it and the remaining half concreted in a like manner. Progress on this work was limited only by the number of invert forms in use, and actually amounted to 168 lin. ft. of completed invert per eight-hour day.

High Line or Trestle

As soon as the invert was completed a trestle was erected upon it. Blaw-steel forms were used for the side walls and roof. The trestle bents were of such height as to bring the top of the floor on a level with the top struts of the steel forms and were spaced about 8 ft. apart. The deck was built of five 2 x 12-in. planks, laid close together, so that only the outside planks needed to be spiked to the bents. The rails were laid on the decking and were held in place by pieces of 2-in. block nailed over the bottom flange, both on the inside and the outside of the rail.

As soon as the trestle was completed the entire length of the tunnel, four 40-ft. sections of forms were set up at equal distances throughout the tunnel, the most northerly form being erected at the north portal. The forms were mounted on carriages, which were moved on rails spiked to wooden blocks spaced at intervals of about 4 ft. Iron straps between the blocks held the track to proper gage.

Handling the Forms

Three sets of forms were in use each day; the side walls were being placed at one, the arch at another, and the key was at the third set. In the meantime the fourth set of forms was being moved ahead. None of these operations interfered in any way with the passage of the concrete cars through the forms.

About two hours before quitting time the form-moving gang, ordinarily consisting of one foreman, two carpenters and four laborers, commenced to loosen up and draw in the set of forms at which the key had been finished the previous day. By the time the concreting gang quit work, at 5 o'clock, the tracks for the carriage had been carried ahead and everything was in readiness to move the forms. Then the 2-in. planks between the form carriage and the invert were taken out and 2-in. rollers inserted between the platform on the forms and the trestle deck. The two outside planks of the trestle were then removed and the form moved ahead by means of a portable windlass. As a bent was reached it was knocked loose and set in place immediately behind the form carriage. In this way the form was moved forward 40 ft. to its new position, when the rollers between the platform and trestle floor were removed and the form jacked into its proper position. It required about one hour to move the forms ahead, but from five to six hours were required to release the forms, jack them into place again, and set up the bulkheads.

Progress and Costs

The dinkey maintained an average of 42 round trips, or 126 carloads of concrete, per day. It would leave the south portal of the tunnel with its three-car train, dump the concrete on the shoveling platform wherever it was needed and return to the hopper, where three loaded cars were ready for the next trip. The length of trip would depend, of course, upon the distance to the farthest form, but an average round trip of 8000 ft. would take between 11 and 12 minutes. The average rate of speed, including all stops, was about 8 miles per hour. An average of 15. gal. of gasoline was consumed per day. About 40 ft. per day were the average progress of the tunnel lining.

More than 5400 lin. ft. of trestle were built; this includes the length of tunnel section in open cut at the north end of the tunnel. The cost of timber alone was $3,200, and since about 2.6 cu. yd. of concrete and dry packing were required per linear foot in the side walls and arch, the cost of the trestle, including the setting up, was about 25 cents per cubic yard of concrete in place. As much of the trestle can be used a second time, the contractors estimate that this cost may be cut practically in half.

The oil-burning locomotive was furnished by H. W. Bell & Company, of Yonkers, N. Y.

Distribution of Sewage Sludge in Settling Tanks

By Charles Hoopes, Associate Engineer with George C. Diehl, Consulting Engineer, Buffalo, N. Y.

Preliminary settling has always been considered an important factor in the treatment or purification of sewage. The recent development of the Imhoff tank has done much to improve this operation and the results from these tanks have been so practical and economical abroad that American engineers are now rapidly adopting them.

There has always been a strong tendency among American engineers to improve and modify rather than to adhere strictly to the details of any new type of construction. This has given impetus to original ideas in design and has brought about freedom from conservatism generally that has been beneficial. Sometimes, however, an important factor has been missed. This seems to be somewhat the case with many recent designs of Imhoff tanks.

One of the valuable features in the Imhoff tank is the manner in which the sludge is concentrated in convenient pockets, if the word may be so used, from which it can be more completely drawn and controlled than under former methods. Pockets of various shapes have been used in American designs, but the uniform filling of these pockets, or, rather, the uniform distribution of the deposited matter in them, has in some cases been overlooked.

American designs with three, four, five and even six pockets are not uncommon. The use of many pockets in our designs is the result, primarily, of the adoption of the rectangular rather than the cylindrical tank. This necessitates frequent cross-walls or extremely heavy construction. By using the cylindrical type a much greater sludge-storage capacity can be obtained and fewer units or pockets, and much less material will be required. More than half of these tanks, as designed and operated on the continent of Europe, are of the cylindrical type, containing only one or two units or pockets. The uniform distribution of sludge in them is simplicity itself, as reversal of flow only is required.

Recently there was referred to the writer for criticism a design for a six-pocket rectangular tank. As designed the settling or flowing-through time was 1½ hours, and, as no arrangement for the reversal was provided, the flow was all one way. The sludge-storage capacity was based on European practice, and much less than should be used in this country, especially in the colder portions, where we must plan for a storage of at least four months as a reasonable estimate. From a study of the curve of sedimentation (Fig. 1) it is plain that the first pocket would receive 50 per cent, the second 10 per cent, and that the remaining 15 per cent would be deposited more or less uniformly throughout the other four pockets. Even if the flow could be reversed, the condition would be but little improved, as the two central pockets would receive only a small portion of their share. In other words, the last four pockets together would receive approximately one-third of the amount of deposited solids that Pockets 1 and 2 would together, while Pocket 1 would receive five times as much as Pocket 2. The settling tanks could not perform their functions under the above-mentioned conditions.

The Problem

In the plan (Fig. 2) the rectangle *A A D D* represents the flowing-through trough, or settling basin, for a three-pocket design. All details of piping, gas, slots, etc., are omitted for the sake of simplicity. The problem would be somewhat more complicated, but the same in principle, if more pockets were used. The lines *A A* and *D D* represent weirs and the spaces between the pockets.

Assuming that the total time through the tanks is 1½ hours, it is evident that each pocket represents a time interval for deposit of 30 minutes, and, with weirs as noted above, the velocity will be uniform.

From Fig. 1 it is evident that Pocket *A B* receives 60 per cent, Pocket *B C* 10 per cent, and Pocket *C D* 5 per cent of the total suspended solids. The flow from left to right, as shown by arrows in Fig. 2, may be called "direct" flow and the flow from right to left "reverse" flow.

If the flow be reversed for the same length of time as the direct flow, the condition shown in Fig. 4, Part 1 will result. It must be noted that the percentages in Fig. 4 are based on total deposits, while those in Figs. 2 and 3 are based on total solids in suspension, of which 25 per cent passes off in the effluent. Pockets *A B* and *C D* each receives 43 1/3 per cent of the total deposited solids, while Pocket *B C* receives only 13 1/3 per cent. It is readily seen that the total sludge-storage capacity is very much less than that expected in the design.

The Solution

Inasmuch as there are several similar tanks built and others designed and practically ready for construction, an economical solution is necessary.

It is evident from a study of Fig. 1 that the troublesome portion of the curve is that for the first 30 minutes; 60 per cent of the solids is released during that period. The remainder of the curve flattens rapidly, and it would be possible to obtain a quite uniform distribution, if this portion only of the curve could be used, by reversing the flow. Uniformity of distribution can be attained, however, by varying the rate of flow in such a manner that the total time of sedimentation in the different pockets is that required to deposit an equal amount in each. It would be possible in this manner to work the tanks in one direction all of the time if it were not for the fact that heretofore it has been deemed advisable to distribute to each pocket the same mixture of sediment as might be permissible. How seriously this might affect the action is somewhat uncertain.

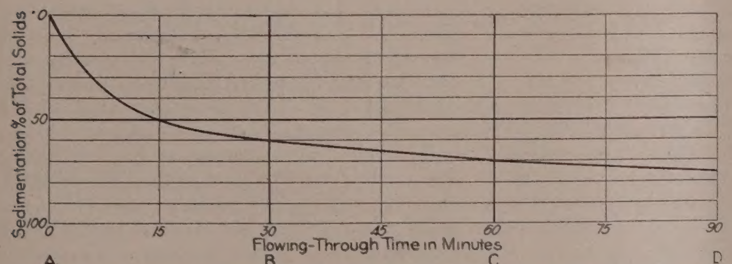


Fig. 1—Sedimentation Curve for Uniform Flow through Tank as Built

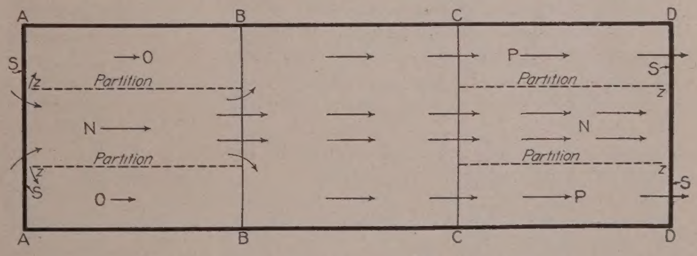


Fig. 2—Plan of Three-Pocket Imhoff Tank

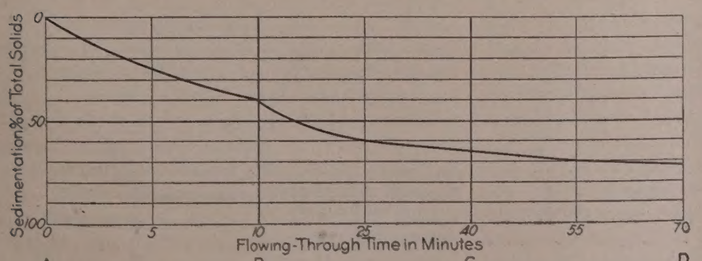


Fig. 3—Sedimentation Curve for Tank Altered to Give Variable Velocity

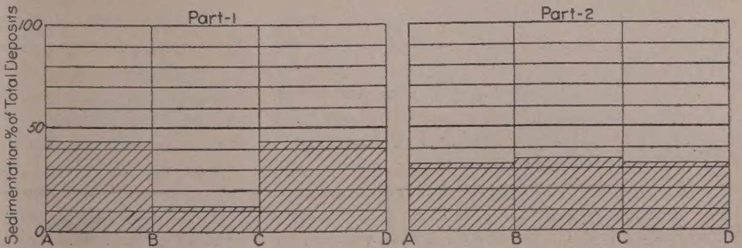


Fig. 4—Amounts Deposited in Pockets for Original and Altered Tanks

Part 1, for uniform flow through original tank; Part 2, for variable flow through altered tank; flow direct and reversed for equal periods

If the time consumed in passing through the end pocket, *A B* or *C D*, for direct and reverse flow respectively, be reduced to 10 minutes, and the remainder of the curve be left as before, Fig. 3 will result. Pocket *A D* now receives 40 per cent, *B C* 25 per cent and *C D* 7 per cent. Reversing the flow for an equal period of time, Part 2, Fig. 4, results. Each pocket has now received an equal, or nearly equal, percentage of the total deposits. The total time of sedimentation is reduced by 20 minutes, but the effluent is not seriously affected. Instead of 25 per cent it now carries 27 per cent of total suspended solids. This shortening of the time would not be necessary in a new design, as a slight change in the trough would make up the difference.

To insure uniform distribution in settling tanks having more than two pockets it is necessary to modify the curve of the first 30 minutes of sedimentation by changing the rate of flowing through, or, rather, the total time consumed in passing the pockets affected.

CONSTRUCTION

The simplest construction to effect the foregoing modification is the installation of light partitions as shown on the plan, Fig. 2. These should be preferably of metal plates, suspended in place and in sections of a size convenient to handle. The bottom edge should be at least 1 ft. above the floor of the settling basin. These partitions should be so placed that the velocity through *N* becomes that required for the time of passing the pocket.

Stop boards, designated by *S*, direct the influent to the narrowed channel *N*. When the flow is "direct," as shown by the arrows, the boards on *A A* only should be in place, and during "reverse" flow, those on *D D*. Small openings, designated by *Z*, allow sufficient flow to prevent stagnation in *O O* or *P P*, as the case may be.

The principle involved—that of changing the time curve—to insure uniformity can be applied to practically any design, but each particular plant must be studied individually.

Condition of Wash Water in Mechanical Filters

The determination of the most economical period for washing a mechanical filter has led to the collection of data on the character of the wash water at the filtration plant at Moline, Ill. The investigation, covering seven months, was made for the purpose of finding some method by which to gage more accurately the proper amount of water necessary to wash a gravity-type filter. The results obtained were outlined by Mr. L. A. Fritze in a paper presented at the recent annual meeting of the American Public Health Association.

The attempt was made to secure some standard for the filtermen to follow for washing the units and do away with the hit-and-miss scheme of physical appearance. The plant is supplied with water of changing color and turbidity, always accompanied with a corresponding change in the alum feed. The use of the turbidity test as the basis for calculating the proper amount of wash water was considered.

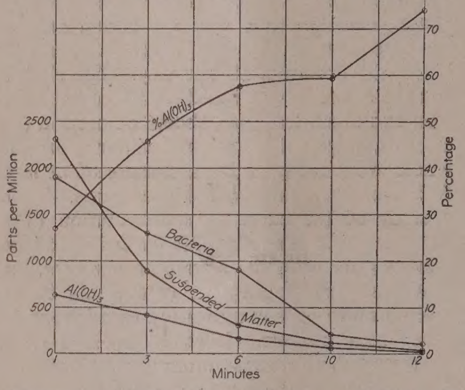
Water, obtained from the Mississippi River, is treated with alum and allowed two and one-half hours for coagulation and sedimentation. As the water leaves the settling basins and flows to the filters a continuous feed of bleaching solution is added. The filter plant proper consists of five 1,000,000-gal. units installed by the Continental Jewell Filtration Company in 1903. In 1911 the filters were completely overhauled; new sand and gravel were added, so that the condition of the beds during the run of these tests was satisfactory.

The usual method followed at the plant for filter washing consists of a five-minute air wash, followed by the water at the rate of 7 gal. per square foot of filtering surface per minute. The water is forced through the sand by a centrifugal pump at the rate of a 9-in. rise and removed through the troughs, the ratio of area of which is 1 to 5, to the filtering surface. Instead of washing by loss of head, local conditions at the plant warranted the washing once in twenty-four hours. The results here recorded are for this period.

The Mississippi River water contains a very fine silt rather than mud. This silt is so fine that very little settles by sedimentation alone, coagulation being necessary.

REMOVAL OF SUSPENDED MATTER

During the first minute of washing the aluminum hydrate forms 27 per cent. of the suspended matter. With continued washing the percentage increases, until at the end of twelve minutes it has risen to 73.7 per cent. While the suspended matter during the first five minutes is reduced nearly 62 per cent, the aluminum hydrate reduces only 35 per cent, showing that the silt is washed away much more rapidly than the hydrate. Results show also that with six minutes of washing almost 87 per cent of suspended matter is removed, while at the same time the hydrate forms nearly 58 per cent of the total. It will be seen from this that, on the average, a six-minute wash practically cleans the filters.



Removal of Suspended Matter and Bacteria

TABLE 1—AVERAGE RESULTS

Time, minutes	Suspended matter, parts per 1,000,000	$Al(OH)_3$, parts per 1,000,000	$Al(OH)_3$ to suspended matter, per cent	Color	Bacteria per cu. cm.
1	2344	635	27.0	15	1900
2	892	410	45.9	15	1300
3	292	168	57.5	15	900
4	123	73	59.3	15	200
5	38	28	73.7	15	110

The ratio of the bacterial removal to that of the suspended matter is fairly well in accord. The platings were incubated at 20 deg. for forty-eight hours with the growth of only 1900 bacteria per cubic centimeter on the average for the first minute of washing. At times as few as 140 bacteria were found for the same period, and the reduction at the end of the washing showed about the same number as were found in the filtered water.

The bleach is fed in continuously in the settled water, just prior to flowing on the filters, at the rate of 0.45 part per million of available chlorine. With this continued action the after effects in the sterilization of the beds of the filters have been of interest.

In a number of plants the bleach is fed in the suction end of the high-service pump or in the water just after filtration. While it is admitted by Mr. Fritze that this is an economical move in dollars and cents, he questions whether the results in the quality of the water furnished are in keeping with the saving.

EFFECT OF BLEACH

The settled water shows on the average 1200 bacteria per cubic centimeter. The difference in the treated and filtered water is 73 bacteria. With 73 bacteria per cubic centimeter as the basis, the total number that would accumulate on the bed of the filter in twenty-four hours would be 861,000 per square centimeter of matte, or 29,000 per cubic centimeter of wash water during the first minute. The actual number found on the average was 1900, and, as has been stated, as low as 140 were found.

Without the use of bleach in the settled water the figures show that for a twenty-four-hour run the number of bacteria that would collect on the surface of the filter would be 14,000,000 per square centimeter of matte, or about 480,000 per cubic centimeter of wash water during the first minute. With no consideration of the multiplication taking place, the figures are probably lower than would actually be found.

TABLE 2—EFFECT OF BLEACH ON BACTERIA

Time, minutes	Bacteria for collection, 43 per cu. cm. Bleach feed 0.43 part per 1,000,000		Bacteria for collection, 110 per cu. cm. Bleach feed 0.50 part per 1,000,000	
	Actual	Calculated	Actual	Calculated
1	1213	17,200	3050	44,000
3	984	13,900	1858	26,000
6	617	8,600	1258	18,000
10	210	2,900	398	6,600

Is a filter matte laden with 14,000,000 bacteria per square centimeter able to filter water without showing some effect in the quality? During the flooded stages of the river this number is probably increased threefold or more, so the accumulation at times is enormous. During these bad stages the bacteria found on the sterilized bed increased to 6,000 per cubic centimeter of wash water, but were reduced at the end of twelve minutes of washing to 200. Further tests on the after effect of the bleaching solution on the beds of the filters are shown by the comparison in Table 2. During one of the periods when the bleach feed was 0.43 part per million chlorine and the difference between the treated and filtered water showed 43 bacteria per cubic centimeter, the organisms found during the first minute numbered 1200. The calculated number that would have been collected was 17,200. Thus about 93 per cent was removed by the continued action.

In another period during a bad stage, with the bleach feed 0.50 part per million chlorine and 110 bacteria per cubic centimeter as the difference between the treated and filtered water, the same condition exists. The calculated number shows 44,000 per cubic centimeter for the first minute, while the actual number found was 3000—a reduction of 93 per cent again. With these tests and others it has been found that on the average 90 to 95 per cent of the calculated number of bacteria is removed by the continued action of the bleach.

The use of bleaching powder in the settled water, Mr. Fritze states, shows that an almost sterile filter bed can be had and maintained through the varying changes of water, and though the operating cost is increased by treating at this point over the treatment of the water after filtration, the results obtained by the former warrant the settled-water feed.

Study for Unification of All Freight Terminals at Buffalo—Part II

Recent Views of George H. Kimball, Who Worked Out in 1904 the Plan for a General Clearing Yard, with a Diagram of the Yard

As stated in Part I, the investigation of the Buffalo Freight Terminals Committee was concluded in 1904. Mr. Kimball's experience and observation since that time have only served, however, to strengthen his belief in the wisdom of the conclusions formulated, and in his paper in the August "Bulletin" of the American Railway Engineering Association he continues with a discussion of his present ideas on the subject. The views herein contained, then, are his, as abstracted from the "Bulletin," and the diagrams are taken in condensed form from the same source.

While it is true that hostility to the idea of open terminals is common, and the thought of placing all railroads and their patrons on an equal footing, so far as terminal service is concerned, with "reciprocal switching" applied to competitive as well as non-competitive business, finds little favor, yet in the main the plan is sound and merits serious consideration.

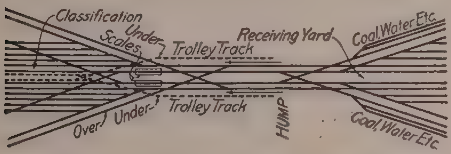


Diagram of Connections at Hump

In the older and more congested districts industrial development has already reached its limit. Where industrial expansion seeks new territory on connecting lines and additional business is within reach, some substantial return as between railroads must be made if a share of new business is to be secured. Furthermore, there are locations where industrial development has been dwarfed by a short-sighted policy in this respect, and the alternative has been presented, and may again be presented, of a choice between open terminals and the assumption of the burdens an independent terminal involves. Shippers have also learned to appreciate the value of a location where there is perfect freedom and flexibility pertaining to transportation.

Unification in Operation Only

The unification of terminals as to operation, however, does not necessarily involve the idea of open terminal territory. Without it the unification of terminal operations would seem to be desirable on the score of efficiency, economy and dispatch. It is not even essential that a terminal association should be formed as a separate entity to take over and hold the terminal property necessary to be combined. An association for the operation of terminals as a unit may be confined to the use of the terminal facilities so combined. The title of ownership to lands, tracks and equipment can remain with the parties in interest. The adjustment of accounts need not be a difficult matter and could be fairly based (1) on the interest on the value of the property contributed by each railroad, equalizing the inevitable inequalities, and (2) on a prorating of the cost of maintenance and service.

An objection has been offered to a clearing yard of the character described simply on the score of its size, with the thought that it might be cumbersome and difficult of operation, but when it is considered that the necessary subdivision of the work reduces the operating unit to what one engine, or its equivalent, will handle at the hump, the objection seems to rest upon no very substantial basis.

Efficiency and economy in operation as a whole will depend finally upon rigid adherence to the operating system; track system and operating system must harmonize and sustain a nice adjustment, but once determined, operating methods must control and be adhered to through thick and thin.

On the score of economy the plan proposed seems to possess every advantage. The estimated cost of the clearing yard, with its facilities and equipment, was, in round figures, $14,000,000, requiring an initial expenditure of $10,000,000. It was further estimated that the economies the proposed system would effect in switching service alone represented the interest at 4 per cent on an investment of $20,000,000. This took no account of the release of large areas of land and extensive trackage that could be devoted to other purposes, nor to many other economies that could not be clearly estimated and possibly not foreseen; but by far the greatest advantage expected from the adoption of the proposed system consisted in relief from periodic congestion, and in relation to this the factor of cost was regarded as secondary. The unit prices that entered into the foregoing estimate are, of course, out of date, but the relative values of the general figures still hold good.

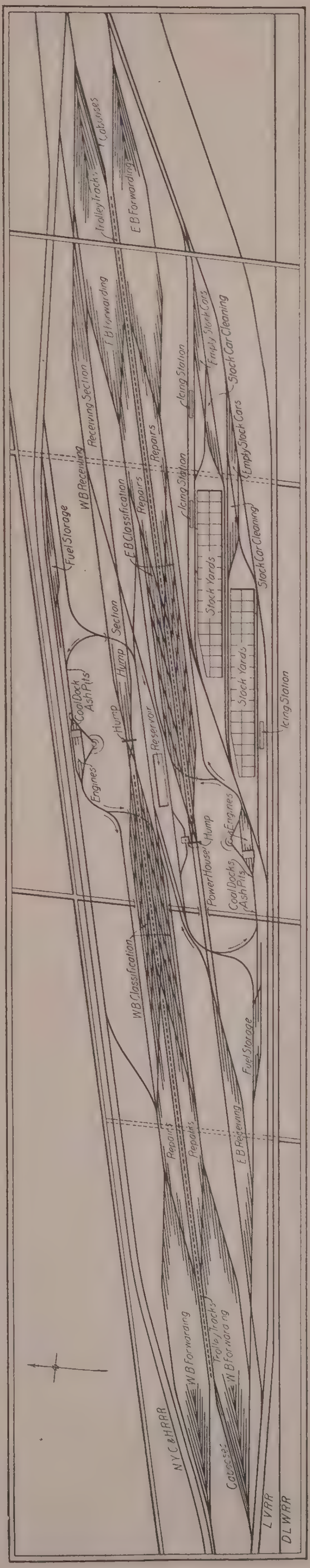
Capacity of Yard

As to the capacity of the clearing yard measured by the estimated flow of traffic through it, it is believed that it was much underestimated. It was not anticipated that all of the tracks in each of the groups composing it would be constructed at one time of the capacity shown, but that beyond a certain limit the adjustment of the relative capacities of the various yards would be determined by use. Doubtless these factors in the problem sustain a certain definite relation for a given volume and character of business in each particular case, that can best be determined under actual operating conditions.

The length of the various groups of tracks composing this clearing yard was based on a train length of one hundred cars, that requirement being specified. It seems to be excessive and hardly justified by the facts in the case. The length of the yard could be materially reduced with economy in construction and further advantage in operation.

The receiving yard, as shown, is believed to be relatively too large, and it could be reduced with advantage. The receiving end is no place to hold cars or allow them to accumulate, and it should be made as small as can consistently be done in any given case. If necessary at any point, cars should be held in made-up trains in the forwarding yard, where the responsibility for delay will rest with the forwarding road. Traffic should be kept moving through the receiving yard, and with sufficient capacity at the hump, as there is believed to be in this case, this is entirely feasible. In cold weather cars should not be left standing long enough for the packing in the oil boxes to chill, so that the cars will run hard, and this should fix the limit of time in any case for cars to remain "dead" on receiving-yard tracks.

The cable-haulage system proposed seems to



Diagrammatic Outlines of Yard Units; Classification Yards Consist of Short Secondary Groups Placed Tandem, with Auxiliary Ladders offer substantial advantages, even if there was no increase in capacity in the number of cars put over the hump in a given time, and with the improvement in electric motors for heavy service that has taken place in recent years, their use in place of steam would doubtless be much more satisfactory.

It was found that the readjustment of grade lines made possible in this case by the assumed adoption of the cable-haulage system resulted in a saving in the cost of construction that fully offset the cost of machinery, together with the necessary concrete structures, and the cost of installation.

Changed Business Methods

There are certain business methods the modification of which would go far to speed up the movement of traffic and reduce or prevent congestion in yards and terminals generally, such as the present methods of billing, which involve notice through yardmaster and agent to consignee and return of information through the same channel, and the practice of storing "hold" cars for the convenience of the consignee who handles his business on reconsignment.

In the first instance there would seem to be no good reason why the card bill that accompanies the car should not carry in addition to the usual information all that is needed to make final delivery, with a duplicate for the yardmaster's use and a triplicate with the car.

In the second instance it is believed that the practice in many places of storing "hold" cars is responsible as much as any one factor for the periodic congestion from which all roads, shippers and consignees suffer alike. From this standpoint there is not a good word to be said for this custom, and with the exception of actual emergencies and cars held for charges it should be everywhere abolished as it has already been in some instances.

Analysis of Traffic Stresses

The forces that cause raveling in a macadam-road surface were analyzed by Col. Edmund A. Stevens, state highway commissioner of New Jersey, in a paper read before the American Road Congress at Detroit. A draft horse weighing 1200 lb. will carry all his weight at one time on two feet. A probable speed is 4 miles per hour, and a fair allowance for rate of work is 1 hp. Then the vertical force at either foot is 600 lb. The horizontal push will be exerted by two feet moving at the rate of 4 miles per hour (or 4 x 88 ft. per minute) with an energy of 1 hp, or 33,000 ft.-lb. per minute; the horizontal force at either foot is thus 33,000/(2 x 4 x 88) = 47 lb. Assuming 2 in. as the width of the toe calk on which these forces are concentrated, the resultant force is 300 lb. per linear inch.

Similarly, a loaded motor truck weighing 16,000 lb. and exerting at the wheel rims 30 hp at 10 miles per hour, assuming 60 per cent of the weight on the rear axle, will exert 4800 lb vertically at each wheel, and (remembering that the two drive wheels furnish all the push) 30 x 33,000/(2 x 10 x 88 = 562.5 lb. horizontally; the resultant is about 800 lb. per linear inch for 6-in. tire.

A 4000-lb. pleasure car, carrying 60 per cent on the rear axle and exerting 40 hp at the rims with a speed of 35 miles per hour, imposes a vertical force of 1200 lb. at each wheel and a horizontal force of 40 x 33,000/(2 x 35 x 88) = 214 lb., nearly. The resultant is about 400 lb. per linear inch for a bearing width of 3 in.

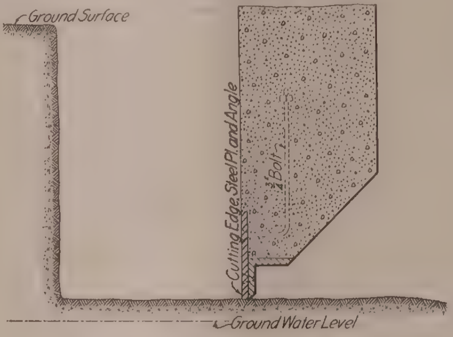
Why Not Sink Imhoff Tanks as Open Caissons?

By E. B. Van de Greyn, Denver, Colo.

Expensive features of Imhoff sewage tanks are the deep excavation, together with its sheathing and bracing, and the difficulty of building forms for the concrete walls of tanks after excavation is completed.

Two years ago the writer designed an Imhoff tank for a city of about 7000 population. The tank was to be located in low ground in which the ground-water level was a short distance below the surface. The soil was alluvial and soft when water-logged. A comparison of estimated costs was made between the ordinary method of excavating for the tank, sheathing the hole to hold up the sides, bracing the sheathing and then building the forms for the walls of the tank and the caisson-sinking method as described below. The saving anticipated from using the latter method was so large that it was selected.

The sketch herewith shows the first stage of the excavation and a section of one wall of the tank. As seen in the sketch, the excavation is carried down close to ground-water level (if ground-water level is a considerable distance below the surface the excavation can be carried down as far as the judgment of the engineer dictates) and the hole made wide enough to allow for building and removing forms. Next the forms for the lower section of the vertical walls are built and the cutting edge is placed. The forms can be run up a convenient distance and then the concrete placed. Just how soon excavation can be resumed, and in what manner, will depend on soil conditions and will be determined by the engineer in charge, it being kept in mind that the concrete should be set sufficiently to stand the downward movement. If the soil is not too soft the excavation in the center could be started at once and that under the cutting edge as soon as the concrete will allow. Before the walls are allowed to settle the forms should be removed. The excavation should be carried down and walls allowed to settle a distance about equal to the length of forms. The operation would be repeated until the walls are in final position. Then the bottom can be excavated for the floor of the tank.



Cutting Edge of Caisson

Bolts, say about ¾ in. in diameter and 2 ft. or more long, should be placed at intervals as shown in the sketch to anchor the cutting edge to the concrete. The walls should also be lightly reinforced, preferably with some mesh reinforcement, to prevent damage during settling.

The savings in this method lie (1) in amount of excavation; (2) in sheathing and bracing, and (3) in ease of placing forms for concrete.

The extra expense involved in the method is due to (1) cost of cutting edge; (2) loss in some cases due to waiting for concrete to set, and (3) extra expense for lightly reinforcing walls, which, in some designs, might otherwise not be reinforced.

Road-Roller Test of 4-Inch Concrete Highway Slab

Tests to ascertain whether a concrete road had sufficient strength to bridge successfully possible burrows by animals or old trenches which settle subsequent to the building of the road, recounted in the latest California Highway Bulletin, indicate that a 4-in. thickness should successfully support a 10-ton road roller under these conditions. Specifications call for a 1:2½:5 mixture but actually 1.3 barrels of cement are used per cubic yard of concrete.

The test was carried out on a road thirty-five days old to which no bituminous wearing surface had yet been applied. Earth under the edge of the concrete was removed for a width of 2 ft., the opening extending back toward the center of the road for 4 ft. from the edge. A 10-ton Kelly-Springfield roller, so designed that one-third of the load is on each rear wheel of 20-in. width, was utilized.

Character of Test

In the first test the roller was run along the road, its rear wheel crossing the unsupported concrete 12 in. clear of the edge of the pavement. The second test was like the first, except that the wheel was only 6 in. clear of the edge of the pavement.

In the third test the roller was stopped and started with the rear wheel on the unsupported concrete, 6 in. from the edge of the pavement. There was no noticeable effect on the concrete in any of the first three tests.

In the fourth test the wheel was passed over the unsupported concrete with its side even with the edge of the pavement, and in the fifth it was made to pass over a 2x4x8-in. block of wood, laid flat, 12 in. from the edge of the pavement and lengthwise with the road. A slight deflection was noticeable in both the fourth and fifth tests as the roller passed over the opening, but the concrete regained its original position immediately after the passing of the roller.

Loads

Assuming that the weight on the block of wood was 3⅓ tons only (weight probably nearer 4 tons, since the roller was supplied with water and fuel), the load in the fifth test was equivalent to 1666 lb. per inch of width of bearing. Looking at it another way, the concentrated load was the equivalent of a wagon with four wheels, each with 4-in. tires, carrying a load of 13 tons equally distributed over the four wheels.

The heaviest load likely to pass over the State highways is the 20-ton traction engine. Assuming that the two rear wheels carry two-thirds of the weight, each wheel would carry 13,300 lb., and if the wheels are only 24 in. wide, the weight per inch of bearing is 550 lb. per inch. The weight used in the tests, therefore, was more than three times as great per inch of width of tire as the heaviest load to which the pavement is likely to be subjected.

As a final test the block of wood was moved to within 6 in. of the edge of the pavement, so that when the roller wheel ran up on the block it overhung the edge of the concrete by about 2 in. In this position the combined weight and the shock due to running the roller on to the block cracked the pavement.

Steel Framework of St. Jean Baptiste Church

Large Double Dome Supported on Columns and Roof Trusses, and Two Towers with Circular Framework and Conical Roofs

The Roman Catholic church of St. Jean Baptiste on Lexington Avenue and Seventy-sixth Street, New York, is cruciform in plan, about 99 x 225 ft. in extreme dimensions and 80 ft. high to the ridge of the main roof. The nave and transept, each 40 ft. wide, have double-pitched roofs, except at their intersection, over which there is a high dome 40 ft. in diameter. At the main entrance the end of the nave is flanked by two stone towers extending up to the top of the main roof, above which they are continued by lighter towers of open construction surmounted by domed roofs. The exterior walls are of self-supporting stone masonry, including the lower part of the dome construction, which is carried on steel girders and trusses. The floors, main roof, and the framework of the dome and towers are all of structural steel carried by columns in the side walls of the clerestory and by the transept walls.

The main nave and transept are about 66 ft. high from the floor to the ceiling. All of the floors are of ordinary beam and girder construction, and the columns in the walls of the clerestory are connected by longitudinal plate girders carrying the clerestory walls. The main roofs of the nave and transept are carried on I-beam purlins supported by riveted trusses of 40-ft. span. Steel beams suspended from the inclined lower chords of trusses carry the vaulted ceiling. Over the sanctuary there is a hemispherical roof carried on one regular truss and three radial semi-trusses.

Dome Support

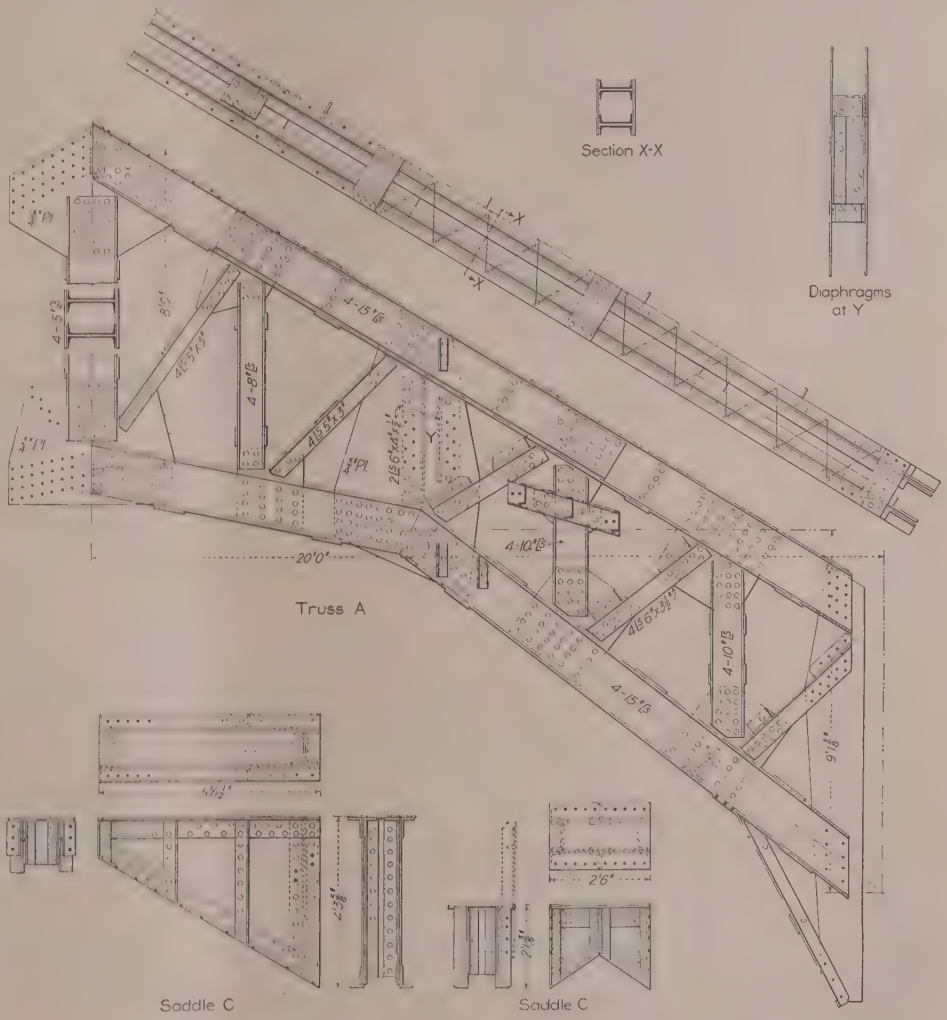
The four main roof trusses carrying the nave and transept roofs at their intersection form a 40-ft. square and have full-depth riveted connections to the four main columns F F F F, each of which sustains a load of approximately 276 tons and is made up of two 15-in. channels and four 17-in. cover plates. These trusses carry not only a portion of the main roofs but also carry the entire weight of the dome and its masonry walls and steel framework, estimated at 1104 tons, including the load from the wind pressure on the dome.

These trusses are extremely heavy and of special construction, with shop-riveted connections at all panel points except at the center and ends, where they were field-riveted to permit the trusses to be shipped in halves. The top and bottom chords are made of two pairs of channels, each pair being riveted together, back to back, with heavy gusset plates between them; both top and bottom flanges are connected by tie plates and lattice bars. Most of the vertical web members are pairs of channels, and the inclined web members are pairs of angles.

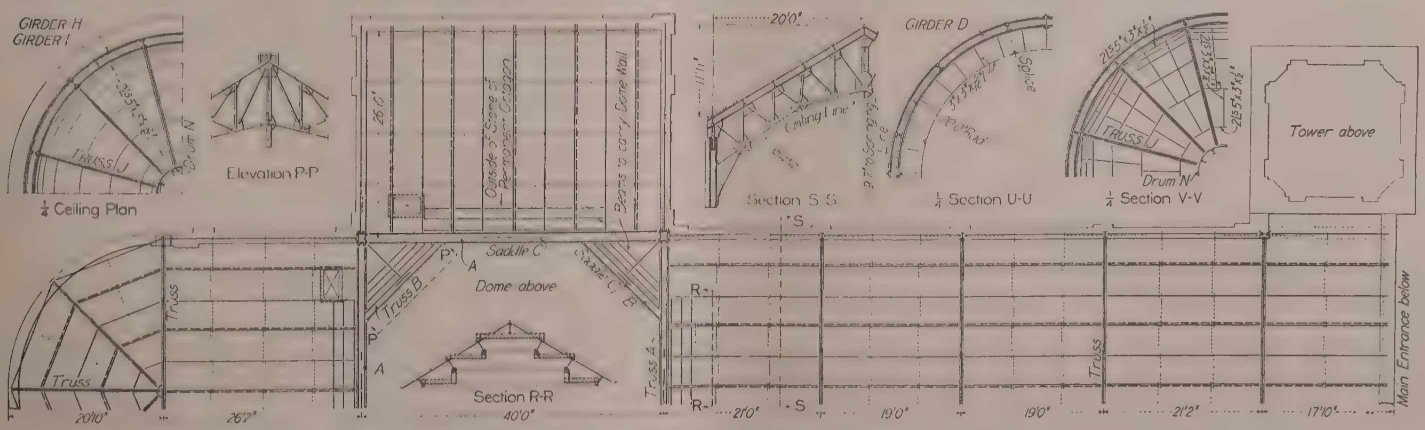
Near the quarter points of each truss, where the inclination of the bottom chord changes, is a wide, full-depth, reinforced vertical web plate affording connection for the bent hitch plates at the ends of the top and bottom chords of short double diagonal trusses B, which with the main trusses A form an octagon concentric with the dome. The trapezoidal-shape trusses B are 8 ft. deep and 16 ft. long, with parallel top and bottom chords, and are made entirely of angles not more than 3 in. wide and connection plates 3/8 in. thick.

The octagon formed by trusses A and B is concentric with and supports the double circular girders D at the base of the dome framework, which carry the dome columns and trusses and the dome masonry. Bearings for the circular girders are provided by saddles C and C_1 fitted to the vertices of the trusses. Each large saddle C is 11 ft. long and consists of two duplicate parts, field-riveted together over the apex of the truss. Each part is a double plate girder of trapezoidal elevation with two 3/8-in. web plates, 10 in. apart on centers, connected by a top-flange cover plate and vertical-transverse plate diaphragms at both ends. The lower flanges are field-riveted to the top chords of the trusses throughout their entire length.

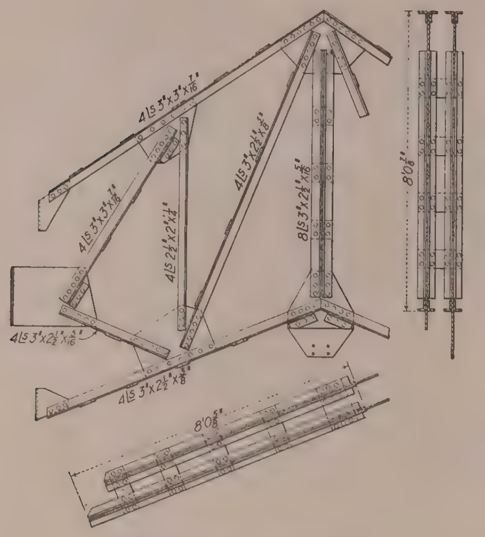
The small saddles C_1 on trusses E are similar



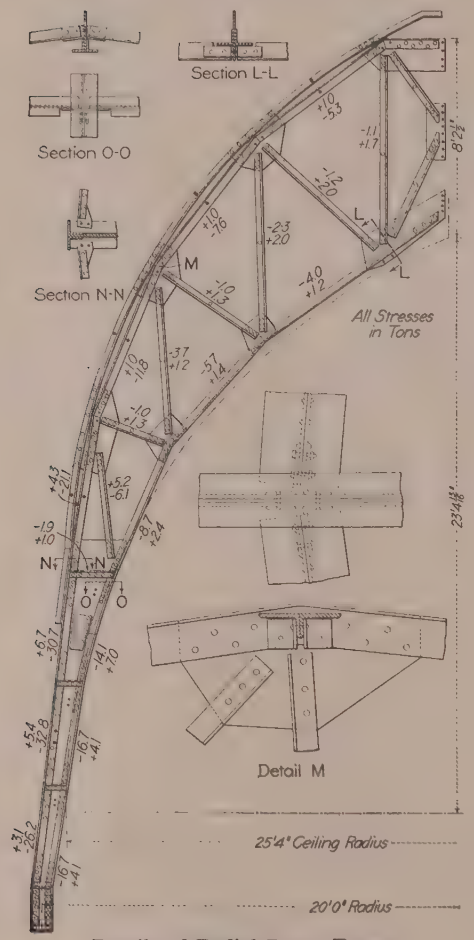
Details of Girder Saddle and Half Elevation of Main-Roof Truss



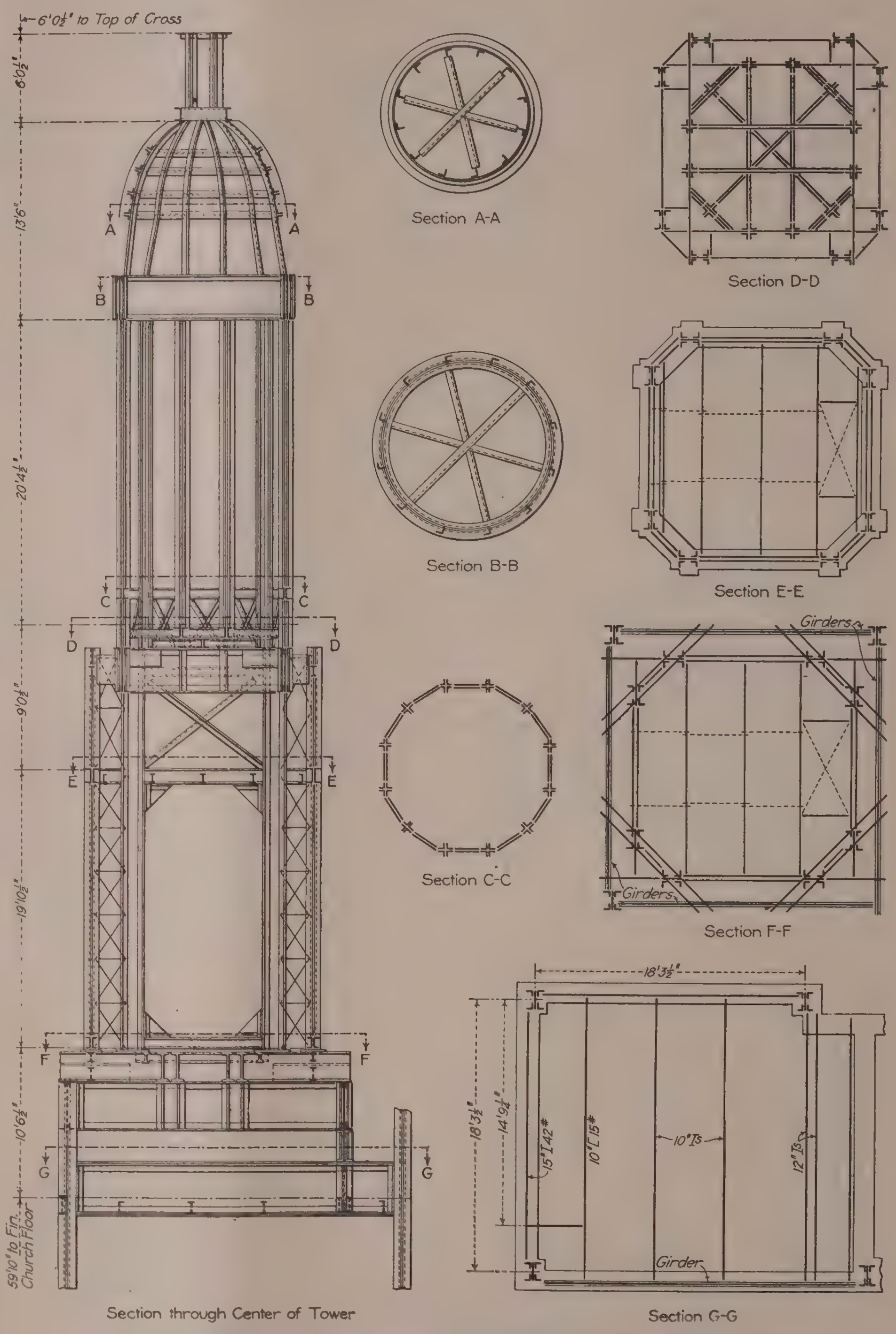
Half Roof Plan, Elevation of Trusses, Supports for Circular Girders, and Quarter Plans of Dome



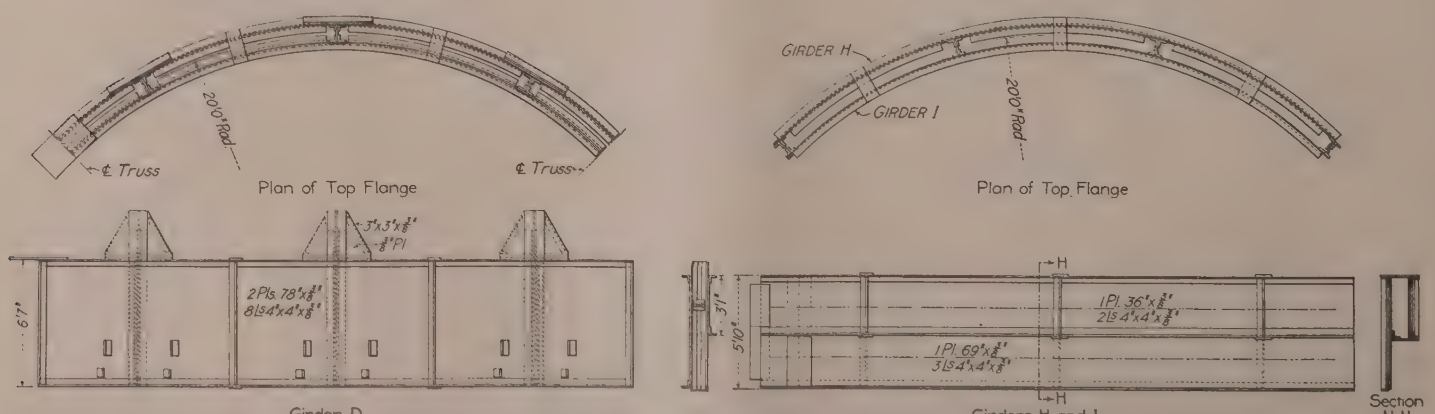
Half Elevation of Truss B



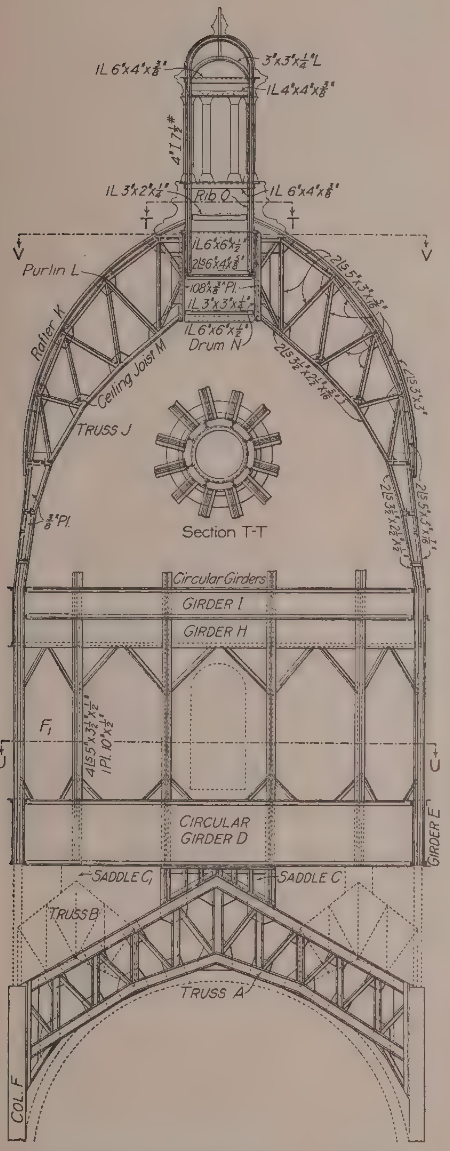
Details of Radial Dome Truss



Sectional Elevation and Typical Framing Plans of Steel Towers



Plans and Elevations of Circular Girders Transmitting Dome Weight to Octagonal Framework



Sectional Elevation of Dome Framing

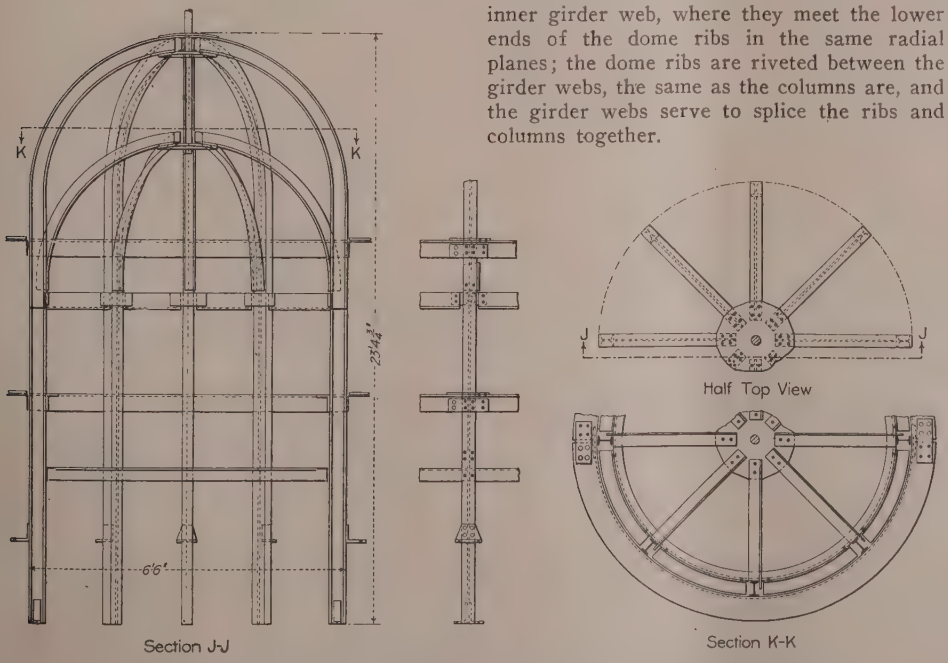
to the large saddles, except that they are much smaller and each is made in a single piece, with the lower flanges notched to fit the top chords of the roof trusses. All the saddles were shipped from the bridge shops with open holes in their top flanges for the field-riveted connections to the bottom flanges of circular girders D in the dome framework.

DOME FRAMEWORK

The base of the dome is a circular steel framework, 40 ft. in diameter and about 27 ft. high, with double annular top and bottom plate girders connected by twelve circumferential columns with their flanges riveted between the webs of the inner and outer girders. The tops and bottoms of the columns are knee-braced by solid-web brackets stiffened by flange angles and riveted to the girder flanges with clearance between them for large windows in each of the panels between columns. The bottom girder D was shop-riveted in four duplicate quadrant sections with double 78 x ⅜-in. web plates, 10½ in. apart.

The inside flange angles were cut to clear the columns and both top and bottom flanges were connected by shop-riveted tie plates intermediate between the columns; but there were no transverse diaphragms between the webs, which are connected only by the columns passing between and field-riveted to them. The sections of the girders are spliced together by field rivets through the end vertical web stiffeners and through top and bottom flange cover plates. The kneebraces are shop-riveted to the top flanges of the girders and are shop-riveted to the short lower sections of the columns, the upper section of the columns being field-riveted between the kneebrace plates, which also serve as column splice plates.

The upper ring of the dome frame consists of a deep, exterior annular girder H and a shallower interior annular girder I, riveted like the girders D, across both faces of the column. The outer girder H and the inner girder I are similar in many respects to the lower girders D. There is, however, a difference in dimensions; also, the kneebraces are field-riveted instead of shop-riveted to their lower flanges, and each flange is made of a single instead of a double angle; the flange of the inner girder I is made of one instead of two angles. The tops of the columns terminate at about the middle of the inner girder web, where they meet the lower ends of the dome ribs in the same radial planes; the dome ribs are riveted between the girder webs, the same as the columns are, and the girder webs serve to splice the ribs and columns together.



Vertical and Horizontal Sections and Half Top View of Lantern Framing

Columns and Girders Supporting Dome

The principal framing of the dome proper consists of twelve radial trussed ribs J, with their lower ends connected to the annular girders I and H and their upper ends connected to the drum M. The trusses are about 32 ft. high and 9 ft. deep at the crown, with a clear span of about 16 ft. The outer flanges are battered about 1:8, and about 20 in. from the lower end they are bent vertical to engage the webs of the circular girders. At the upper ends of the trusses these flanges and web members are field-riveted through their gusset plates to vertical connection angles on the exterior of a web of a cylindrical plate girder, 10½ ft. deep and about 9 ft. in diameter, which forms the drum at the top of the dome. The drum has a ⅜-in. web plate and pairs of 6 x 6-in. flange angles. It was shop-riveted in two equal sections and spliced by web and flange cover plates.

The dome ceiling is carried on six horizontal annular rings attached to the inner flanges of the radial trusses, as shown in the general sectional elevation and in the ceiling plan. The heavy dome roof is carried on radial curved rafters with T-shaped cross-sections made up of pairs of 3 x 3-in. angles, supported on horizontal purlins connected to the dome trusses at panel points. The purlins have also T-shaped cross-sections made of pairs of 3 x 3-in. angles bolted to the dome ribs.

The top of the dome is accessible by an exterior curved steel ladder bracketed to the dome ribs and set clear of the roof masonry. A footbridge between the dome ribs, just above the haunches, connects this ladder with a door through the drum web.

DOME LANTERN

The dome is surmounted by a steel lantern with a circular framework 6½ ft. in diameter and about 23½ ft. high. It has eight radial ribs made up of vertical 4-in. I-beams, with the upper ends curved to support a domed roof and field-riveted to top and bottom flange center plates, which are pierced with a 1½-in.

hole for a vertical steel cross-shaft. About 26 in. below this connection the shaft engages another horizontal spider plate connecting the upper ends of eight curved angles supporting the framework of the inner dome which carries the ceiling. The vertical I-beams are connected by three sets of interior and three sets of exterior horizontal angle rings, field-riveted to their flanges. These angles are bent to semicircles, and are spliced with horizontal flange cover plates, shop-riveted to one and field-riveted to the other.

In order to provide temporary roof under the dome during its construction the opening was spanned by a pair of 24-in., 84-lb. I-beams, parallel to the axis of the nave, and each of them about 5 ft. from it. These I-beams supported 6 and 8-in. I-beams at right angles to them, having their opposite ends carried on the octagonal framework of the dome, and the system thus formed was covered with wooden sheeting and waterproofed. This afforded protection for the interior and permitted the erection of the dome and the construction of its roof and ceiling to be carried on more slowly, without delaying the rest of the building, the interior work or its occupation.

Steel Towers

The two steel towers in the front of the church are supported on four steel columns built into the masonry walls. The tops of these towers carry double rectangular tiers of beams and girders supporting the steel superstructure. The upper tier has four plate girders, 40 in. deep, carrying an octagonal framework of horizontal I-beams which support vertical I-beams; these in turn support vertical I-shaped columns at their angles. All of the columns are seated directly on the plate girders, with relatively long panels between them on the girders and short panels between them at the corners.

The plate girder framework supports an upper tier of twelve vertical columns, 22 ft. long, which form elements of a cylinder 11½ ft. in diameter. These columns are inclosed in stone shells and form an open colonnade, surmounted by a dome supported on circular girders 24 in. deep and 11½ ft. in diameter.

Fitted on the circular girder is a dome framework made of six radial 6 x 4-in. angles in vertical planes, having their lower ends riveted to the top flange of the girder and their upper ends riveted to the inner surface of the vertical web of a drum 38 in. in diameter, made of one 10-in., 15-lb. channel with two web spliced joints.

The framework above the roof was erected by steel guyed derricks seated on the surface of the ground and by wooden stiffleg derricks installed on the steelwork.

Mr. N. Serracino, of New York, was the architect and consulting engineer, and the Hinkle Iron Company, of New York, was the contractor for the fabrication and erection.

Stream-Flow Investigations in New York State are being conducted by the water-resources branch of the U. S. Geological Survey in co-operation with the State engineer and the State Conservation Commission. Forty-five gaging stations on streams, twenty-three of which discharge into the Atlantic, twenty-one into the St. Lawrence, and one into the upper Ohio River, are maintained. Daily observations of the stage and discharge of these streams are made. The data so acquired are expected to be useful in the design and maintenance of power plants, in river improvement and flood prevention, and in establishing water supplies.

Brick Pavements in Baltimore

Abstract of Discussion by R. Keith Compton, Chairman, Consulting Engineer, Baltimore Paving Commission, before Third American Road Congress at Detroit

The first brick pavement laid in Baltimore was constructed about 1892 on St. Paul Street between Biddle and Preston. It was laid on a 4-in. base of concrete and a sand cushion anywhere from ½-in. to 3-in. in thickness. The brick was about the same size as the ordinary building brick, wire-cut, with straight edges, and of red shale. Instead of laying the courses at right angles to the curb, they were laid herringbone fashion, the most expensive way to lay a pavement. Sand was used as a filler. After giving 21 years' service, one half of the block has been removed; the other half is still in fairly good shape. I cite this to show that even in the early stages of brick construction good work was sometimes accomplished.

We next used re-pressed brick, with lugs; in 1911 23 miles of vitrified block—some of poor construction, some fair and some excellent—had been laid. From Jan. 1, 1912, to Sept. 1, 1913, we have put under contract about 243,000 sq. yd. and have completed 182,000 sq. yd. Some of this work is on very heavy traffic streets, most of it withstands medium traffic, while a small portion of it is alley work. Probably 5 per cent of our brick so far is on a 4-in. base, with 95 per cent of it on a 6-in. base.

Present Principles of Laying Brick Pavements

While we do not use a template in finishing our concrete, the contractor is required to make it of such consistency and to ram it in such a way that it presents an even and smooth surface. On a 6-in. concrete base stone passing a 2½-in. screen, and on a 4-in. base stone passing a 1½-in. screen is allowed to the extent of 20 per cent of the total mass; but in no instance must the longest dimension of any stone be more than one-half the thickness of the concrete base.

Our specifications first required a compressed sand cushion 2 in. thick, but, to overcome a tendency to exceed this on the part of the contractor's foreman and the city's inspector, we finally reduced our cushion to 1½ in., and, owing to the smoothness of our concrete, there is very little variation from this depth. We find that the thinner layer is more easily compacted, an important detail in the proper construction of vitrified block pavements. When the sand cushion is not compact and firm the grouting is more apt to break and jump out, due to the vibration of the brick under traffic. Furthermore, the rumbling sound so frequently noticed from teams passing over a brick pavement is due in a large measure to this lack of compactness. I recommend a loamy sand preferably with 10 or 15 per cent of loam, rather than a perfectly clean material.

The most practical way to determine whether or not the sand cushion is sufficiently firm is to step on it evenly but firmly, gradually throwing the entire weight on it. If there is a decided imprint, the cushion should be re-rolled.

Laying of Good Brick

Brick should be hard (not so hard as to be brittle, however), well and uniformly burned, and free from warps, fire-cracks and other defects. Uniformity is extremely important. A street composed of uniform brick will wear evenly and will always present a good appearance if otherwise well constructed. The breaking of joints is another important item and when cutting brick to fit in next to the curb the cut end should be placed away from the curb rather than against it to give a better finish.

In my judgment it is a great mistake to lay the brick too close, just as it is to have too loose paving. If laid too close it is impossible to obtain a sufficient amount of grout in the end joints. If laid too loose, however, while rolling the brick will rock and the sand is apt to come up into the joints. This latter fault is a very important item and should be guarded against to the limit. While the brick are being rolled the inspector should carefully follow the procedure, and if the sand cushion is coming up the brick should be immediately removed and the sand cushion restruck; if necessary, re-rolled. The appearance of more than ¾ in. depth of sand in the joints seriously obstructs the admission of the cement grout.

Application of Cement Filler

I am a firm believer in a cement-filled joint rather than a bituminous-filled joint for brick pavements. Cemented joints protect the edges of the brick and give a monolithic construction, while bituminous-filled joints are deficient in these respects. Two years ago I saw bituminous-filled streets completed in the most workmanlike manner and the streets left with a good even surface. Today the brick have been rounded on the edges, and the surface has become decidedly uneven, the brick having shifted and floated on account of the bituminous-filled joint.

Some years ago we tried a cement filler mixed two of cement and one of sand but found this too brittle and returned to the 1:1 mix. If this filler is mixed and applied as outlined in Mr. McCleary's paper (abstracted in Engineering Record, Oct. 11, 1913, page 407), no trouble should be experienced, but it is imperative that the minutest detail of the selection of the sand and cement, the mixing, the application, and the covering with sand after the filler is otherwise completed, be complied with. The slightest deviation from one of these details is more than likely to cause trouble.

It is bad practice to follow too closely the application of the filler with the sand cover. The sand cover can only be used to protect the cement filler from the hot rays of the sun or from frost. It is very important that two or three hours should elapse between the time that the filler is completed and the time when the sand cover is applied, as a too early application of sand will not only cover up slack joints but may seriously weaken the cement filler.

As is well known, only the side joints next to the curb are necessary. Every precaution should be taken to have these joints free of foreign matter so that the pavements will have the full advantage of a clear joint filled from the top to the bottom with either a good bituminous filler or the patented "Elastite" joint.

The following thicknesses of joints next the curb are recommended: On streets between 30 ft. and 50 ft. in width, 1¾ in.; on streets between 20 ft. and 30 ft. 1 in.; on streets between 10 ft. and 20 ft., ¾ in.

If all of these details are strictly complied with there will result a street possessing durability, ease of traction and a pleasing appearance; further, it will have a sanitary surface and will necessitate only a moderate maintenance cost.

Plane-Table Survey in Asia Minor

Experiences in Mountain Work with Turkish Rodmen, and Sidelights on the People, Country and Climatic Conditions

By Lloyd T. Emory, Assoc. M. Am. Soc. C. E., of Emory & Eisenbrey, Engineers, Philadelphia

The ordinary methods of making surveys, upon which nearly every engineering project is based, are so well known that it is only when there appears an account of some unusual work, or a piece of ordinary work handled in an unusual way, that it is of general interest. The writer was recently engaged to accompany an archæological expedition sailing for Asia Minor for the purpose of making a topographical map of the locality surrounding the ancient city of Sardis, where the expedition has been operating for the past three seasons.

Sardis is located among the foothills of Mount Tmolus, near the plain of the River Hermus, about 60 miles inland and in an easterly direction from Smyrna. It lies about 175 miles south from Constantinople. The city was founded about 1200 B. C. and was the capital of the ancient kingdom of Lydia. Owing to its command of the intersection of two of the principal caravan routes it increased in importance, until in the time of Crœsus the fame of its fabulous wealth reached Cyrus of Persia and led to its capture in the sixth century B. C. After this the city was ruled successively by the Persians, Greeks, Romans and Byzantines. It was especially celebrated for its golden ornaments and as being the first city to mint gold coins. It was finally destroyed by Timour the Tartar in 1402, and except for one or two small villages of shepherds it has since remained practically uninhabited.

It can readily be seen that a city occupied for 2600 years and destroyed a number of times by invading armies and the elements furnishes a rich field for the archæologist. Of the ancient buildings little is left above ground except huge piles of broken masonry. Numerous fragments of carved marble and terra cotta, many of which show that they were brought from distant lands, attest its former magnificence. Among the purposes for which the map was made were the location of the Lydian tombs, the Greek temple of Artemis, the Roman aqueduct and the ruins of the Roman walls, baths, gymnasium and theater.

Traveling Inland from Smyrna

From Smyrna inland the journey was made on the Smyrna, Cassaba & Prolongment Railway. Although eight hours were consumed in covering the 60 miles, the time seemed comparatively short on account of the opportunity afforded to see the country and its people. The railroad, built by the French, but now operated by an English company, follows west around the shore of Smyrna harbor for about 8 miles; it then swings around the foot of Yemanar Dagh, a mountain 3000 ft. high, turns to the eastward through a pass and proceeds up the valley of the Hermus River. Magnesia, a town of 35,000 inhabitants, is the chief place passed en route. About 5 miles east of Magnesia is a rock sculpture called the "Seated Niobe," which is probably of Hittite origin. Although the limestone cliff in which it is carved is a mile or more from the railway, it can be easily seen from the train when the sun is high enough to shine on the face of the rock.

As the time allotted to the map making was limited to about five weeks, and the expense of taking out a large party prohibitive, it was decided to make a plane-table survey based on a framework of the most prominent points, whose positions were fixed by triangulation. The expedition had built a very comfortable house near the center of the work two years before, and with the efficient native servants originally brought from Jerusalem the many difficulties which are often experienced in camping under similar conditions were avoided.

The field party was composed of the topographer, one American assistant and three or more native Turks, as the occasion required. The natives were mountaineers who had spent most of their lives as shepherds, were totally uneducated and could not speak a word of English. By the end of the first week they were very efficient rodmen, and it was due to their agility in getting over exceedingly rough country that the large area was covered in such a short time.

Osman, the Instrument Bearer

The northern end of the area consists of an alluvial plain, a portion of the valley of the Hermus River. The central part is a range of hills composed of a reddish cemented-gravel formation, back of which the country is badly broken, but generally slopes south toward the foot of a blue-limestone ridge rising to an elevation of 2400 ft. This ridge is one of the lower terraces of Mount Tmolus, the crest of which reaches an elevation of more than 6000 ft. The streams which rise among the snow-covered peaks of Tmolus flow through gorges in the limestone ridge and have cut into the gravel formation nearly to the level of the plain, leaving peaks, which ascend to a height of 1000 ft. and whose precipitous sides, rising from a succession of lower terraces, closely resemble the buttes of our Western Bad Lands.

There is practically no timber on the area surveyed. A few stunted pines in the waddies and on the slopes of Tmolus, together with a low growth of ilex on the north side of the hills, constitute the principal vegetation, except along the Pactolus, where several groves of plane trees and poplars have evidently been planted. Most of the surface of the ground, except the rugged hillsides, is covered with a fine green turf.

Triangulation Survey

Work on the survey was started the day after the arrival of the party in the field. The first three days were spent in making a reconnoissance. With a native guide and interpreter the writer went carefully over the 4200-acre area to be mapped, and visited the most important features to be located.

After this preliminary work the selection of the triangulation points was made. Two points were obviously such controlling points that they were selected at once. Two points as ends of a base line were then fixed on the railroad which traverses the plain. To insure triangles which were as nearly equilateral as could be obtained, two intermediate points were chosen on the level ground between the railroad and the base of the hills. In making the choice of the points to control the valley of the Pactolus, it was desired to keep all angles of observation larger than 20 deg., and this with two exceptions was accomplished. The base line was measured along the top of rail in order to have the entire length of the steel tape used supported. A temperature correction was applied, and also a correction for the difference in elevation between the ends of the base line.

The measurement of angles could not be carried forward continuously from the base, as the nearness of the sun to the horizon during most of the day in February made it impossible to make observations on certain stations in the early morning and late afternoon. Each station was occupied at a time when the light was most advantageous. It was not always found practicable to complete the measurement of all the angles at one station during a single occupation, but all angles of each triangle were measured. The instrument used for this work was a light Gurley transit reading to minutes.

Each angle was measured twice with the telescope direct. After plunging the telescope the angle was again turned twice, the first, second and fourth angles being read to the nearest minute and estimated to the nearest fifteen seconds. These readings were averaged to obtain a mean reading, and if the mean varied more than thirty seconds from the initial reading the series was repeated. Owing to the graduation of the instrument it was found upon experimenting that a larger number of repetitions than this did not tend to produce more nearly accurate results, and so after one or two trials the above-mentioned method was adopted.

A night observation was taken on Polaris to determine the true north. On beginning the computations the observed angles were adjusted so that the three angles of each triangle totaled 180 deg. In calculating the sides of the triangles seven-place logarithms were used. A check was obtained as far as possible by building on a system of quadrilaterals and computing both diagonals.

Plane Table Work

It was desired to adopt as large a scale as practicable and still have the entire work on one field sheet. The points were therefore first roughly plotted on an extra sheet with a beam compass to a scale of 1/8000, and then the entire scheme was shifted to fit the best position on a field sheet of Whatman's cold-press drawing paper, linen-backed.

For filling in the topographical details a Sterling plane table having a board measuring 24 x 31 in. was used. The alidade was fitted with a telescope with stadia hairs, stride level, clamps and tangent screws similar to an engineer's transit. To keep the weight of the outfit as low as possible flexible pocket leveling rods graduated in centimeters and meters were provided. On arrival at Sardis these were fastened to light strips of pine ⅞ x 3½ in. and 12 ft. long. Owing to the reflection of the sun on the white paper a large umbrella was also found necessary to shade the table.

The first two points occupied with the plane table were the ends of the base line. The plotting was tested by orienting the plane table, which was accomplished by sighting along the base and then taking sights on the first set of triangulation points. This checking was repeated as each of the triangulation points was occupied. All measurements for filling in the details were made by stadia, the readings being reduced to actual horizontal distances and the elevations being computed with a Cox stadia computer. This instrument, which is made of cardboard, was found to give results well within the limit of accuracy required by the scale used, and proved to be invaluable as a time saver.

The topographical features around the triangulation points were first read and plotted, after which stadia stations were located either by reading an advanced point or by the three-point method. The fact that the plane table could be set up anywhere within view of three triangulation points, and a new position determined by resection, made this instrument invaluable. It allowed the topographer to pick stations from which the greatest amount of detail could be obtained, and on account of the extreme roughness of the country these stations often had to be selected on the tops of the smaller buttes or ledges overhanging the canons.

LOCATING THE CONTOURS

Readings were taken on the principal features along the streams or valleys and the tops of the ridges. Contours with 5-m intervals were sketched in when possible as the work progressed, but owing to the efficiency of the rodmen it took most of the topographer's time to read the rod, reduce and plot the readings as made. After reading all points convenient to the station the remaining contours were sketched in by eye, with the exception of several uniform slopes, which were thoroughly controlled and later worked up at night. It was found advisable not to sketch very much beyond the distances read by the stadia rod and when another station was to be occupied in advance to leave the distant details on that side to be filled in after occupying the new station, thus giving the topographer two views of the same country, which often modified to a considerable extent his interpretation of it. The location and elevation of numerous inaccessible points were determined by intersecting lines from two or more stations. For this method the plane table is especially adapted.

Mustapha, the Chief Rodman

Because of the great difference in elevation which often existed between the rod and the instrument it was found advisable to teach the rodman to hold the rod as nearly as possible at right angles to the line of sight of the instrument. This was done by sighting along the edge of a 90-deg. triangle held against the edge of the rod. The reconnoissance occupied three days, the triangulation four, and the plane-table work twenty.

WEATHER AND CLIMATIC CONDITIONS

When the party arrived at Sardis the nights were rather frosty, but a remarkably clear atmosphere, dry air and an almost complete absence of wind made the days very comfortable; it was often fairly warm at noon. During the five weeks only four days of field work were lost on account of bad weather. Perhaps the most striking phenomenon was the ease with which sound would carry. The shepherd boys were able to shout conversations to one another across valleys 2000 or 3000 ft. wide. Often the tinkle of camel bells could be heard on the mountain as a caravan crawled slowly along the trail 2 miles or so out in the plain. This characteristic of the air contributed much to the speed of the work, as instructions could be shouted to rodmen at any distance within the reading range.

The writer went to Turkey with the usual prejudice which most Americans have against the race, but the simple and straightforward manners, honest dealings, hospitality and lack of commercialism of these almost-primitive people of the interior, the class who have had to bear the brunt of the past war, made him a strong Turkish sympathizer.

Production of Bars for Reinforced-Concrete Work

The production of iron and steel bars for reinforced-concrete work in 1912 amounted to 274,332 tons, as compared with 258,741 tons in 1911, an increase of 15,591 tons, or over 6 per cent. Of the total in 1912 about 2,500 tons were iron, as compared with about 2,388 tons in 1911, and about 271,832 tons were steel, as compared with about 256,353 tons in 1911, according to statistics given out by the American Iron and Steel Institute.

The following table gives the production by States of concrete bars in 1912, iron bars being separated from steel bars.

PRODUCTION OF REINFORCING BARS BY STATES IN 1912

	Iron, tons	Steel, tons	Total tonnage
Me., N. Y., and N. J.	.....	69,755	69,755
Pennsylvania	.....	73,639	73,639
Ga., Ala. and Texas	.....	13,005	13.005
Ohio	.....	8,728	8.728
Indiana	.....	24,902	24,902
Illinois	.....	33,803	33,803
Mich., Wis. and Mo.	.....	18,907	18,907
Col., Wash. and Cal.	2,500	29,093	31,593
Total for 1912	2,500	271,832	274,332
Total for 1911	2,388	256,353	258,741
Total for 1910	4,645	236,464	241.109
Total for 1909	.....	159,352	159,352

In 1912 there were thirty-six plants in sixteen States which rolled iron or steel bars for reinforced-concrete work, as compared with thirty-three plants in sixteen States in 1911. Pennsylvania made over 26.8 per cent of the total production in 1912, against over 29.1 per cent in 1911, and New York made over 24 per cent, against over 21.9 per cent in 1911. The next largest makers in 1912 in the order of their prominence were Illinois, Indiana, California, Wisconsin, Ohio, Alabama, Colorado, Washington, Georgia, Texas, New Jersey, Maine, Michigan and Missouri.

Typical View from One of the Mountain Tops

Plane-Table Party at Work in the Field

Allowable Use of Small Angles in Surveying

By W. H. Rayner, Instructor in Civil Engineering, University of Illinois

Every engineer and surveyor knows that for accurate results he cannot rely on computations which involve the sines and tangents of small angles, but his idea of just what relation exists between these functions and the degree of accuracy he desires is usually rather vague.

Obviously the reliability to be placed in any values dependent on the measurement of angles is determined by the accuracy with which the angles are measured. Under ordinary conditions, with a transit or sextant reading directly to minutes, it may be assumed that angles will be measured with a probable error of about 30 seconds, and the accompanying curves have been drawn on that basis. For other degrees of accuracy a direct proportion obtains and results may be derived from the curves. Curves have been drawn only for the functions of sines and tangents, but their adaptability to cosines and cotangents will readily be seen.

An example or two will illustrate the use of the curves. Suppose it has been decided that in a given traverse or system of triangulation the ratio of error must not exceed 1/2500, which corresponds to an accuracy of 0.04 per cent. The horizontal line which corresponds to this ratio intersects the ratio curve for tangents (Fig. 1) at two points whose abscissæ are 23 and 67 deg. respectively. Hence in this survey, if computations involving tangents are to be made, the angles must lie between 23 and 67 deg. The percentage curve may be used in a similar manner. When sines of angles are involved, the lower limit is the determining factor, since the value of the sine changes rapidly only for small angles, and Fig. 2 may be used in a similar manner. In the case given above the lower limit would be 20 deg.

If it were impracticable, however, to limit the size of angles to 23 and 67 deg., then an instrument reading to 20 seconds, or the method of reading angles by repetition, would be necessary. Suppose, then, by one of these means the probable error in reading angles were reduced to 15 seconds, or half the former value. The curve may then be adapted to this case by changing the numerical values of the ordinates to half their value, or by dropping the line to the indicated value of 1/1250. This line intersects the ratio curve (Fig. 1) at the points whose abscissæ are 11 and 79 deg., and accordingly these angles would constitute the limits for a ratio of error of 1/2500 for angles measured with a probable error of 15 deg. Referring to the sine curves it is seen that the lower limit in this case would be 10 deg.

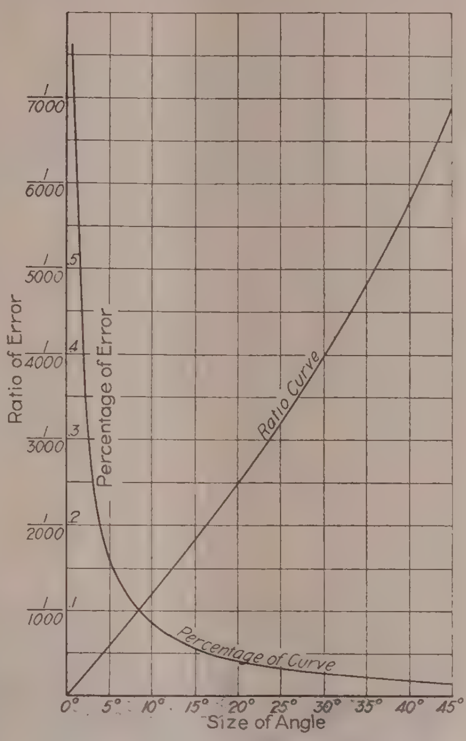


Fig. 2—Curves for Sines of Angles

In systems of triangulation such as those carried out by the U. S. Geological Survey the lower limit of the size of angles is often taken as 30 deg. Let us see to what ratio of error this corresponds. From Fig. 1 it is seen that the ordinate for the angles 30 and 60 deg. equals a ratio of 1/3000, but this applies to angles measured with a probable error of 30 seconds. In such work as has been referred to the probable error of reading angles is reduced to about half a second, or, in other words, about sixty times the accuracy assumed in the curves shown is obtained. Hence the ratio of error would equal about one-sixtieth of 1/3000, or 1/180,000. From the sine curve this ratio would be 1/240,000.

Of course, in all these cases the maximum error has been under consideration and the average error in computations would be much less, although for strict consistency of results the maximum error is the controlling factor.

These curves should be useful to the surveyor or engineer in enabling him to decide quickly and accurately the limiting size of angles if he desires consistently accurate results, and whether or not more refined instruments or methods of measuring angles will be necessary under any given conditions. Other uses of the curves will be evident in any connection where computed results depend on measured angles.

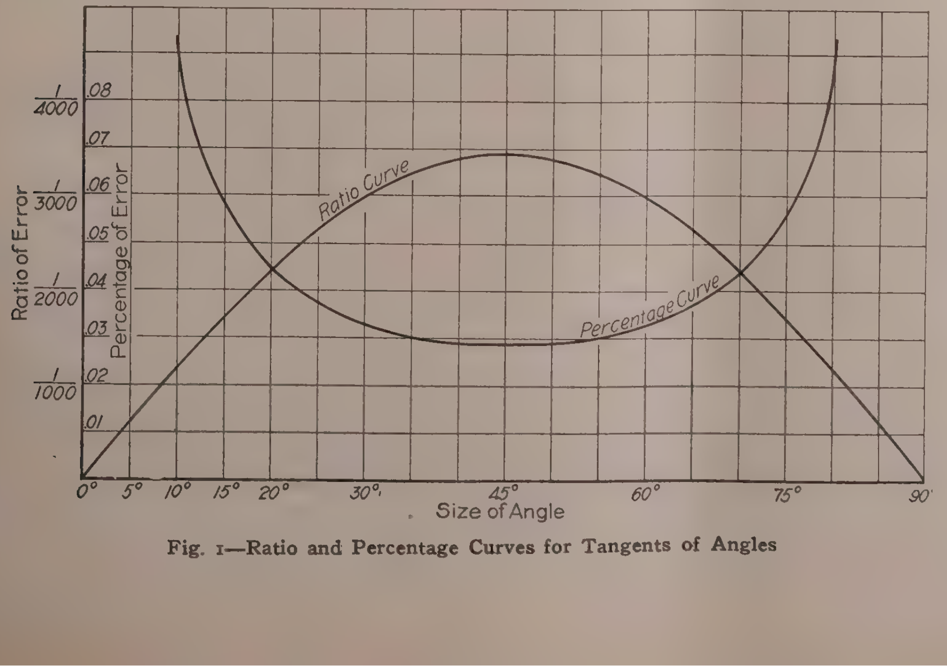


Fig. 1—Ratio and Percentage Curves for Tangents of Angles

Flood Losses in the Ohio Valley in March-April, 1913

In their paper on the Ohio Valley flood of last spring, published recently by the U. S. Geological Survey as Water Supply Paper 334, Messrs. A. H. Horton and H. J. Jackson have included a chapter on flood losses, which is reprinted below with slight alterations.

Estimates of damage caused by the flood are given in the table. These estimates were prepared by the Survey from information received in response to circular letters sent to the officials of about 200 cities and towns of about 5000 population or over, from which about 120 replies were received. These replies gave estimates of losses sustained by the municipalities and some of the smaller towns in their immediate vicinity. The two largest single items received were from Dayton and Hamilton, the total amounts being $100,000,000 and $15,000,000 respectively. Some of the most serious losses were only vaguely expressed. For example, it was reported that at Hamilton two-thirds of the town was covered by water and about 300 houses were swept away; and that at Portsmouth, Ohio, four-fifths of the city was inundated. Such estimates were not included in the tables from which the totals given in the table were obtained. It will be readily appreciated that accurate estimates of flood losses are, at best, difficult to obtain and can hardly be expected to result from the method that the Survey was forced to follow because of the lack of means to make a study at closer range. However, the estimates given are believed to be reliable so far as they go. They should be of considerable value in showing the vast amount of money lost because of a single flood, thus giving some idea of the amount of funds that it is wise and proper to expend in order to prevent the recurrence of such losses.

ESTIMATE OF DAMAGES IN OHIO VALLEY BY FLOOD OF MARCH-APRIL, 1913

(Total population, 14,400,000; drainage area, 203,000 square miles)

State	Towns which reported*	Lives lost	Buildings flooded	Bridges destroyed	Damages Total	Damages Municipal and county improvements†
Illinois.......	11	2	380	..	$1,003,750	$7,250
Indiana	47	39	15,450	180	15,480,143	3,113.900
Kentucky	24	1	6,721	6	1,881,500	130.000
New York...	1	0	200	8	150.000	10.000
Ohio	94	367	33,833	220	‡143,197,492	7,296,083
Pennsylvania.	7	2	690	4	2,935,000	22,000
Tennessee ...	1	0	100	1	50,000	......
West Virginia	21	4	2,669	..	3,477,500	82,950
Total	206	415	60,043	419	$168,175,385	$10,662,183
Total damage to railroads.......					12,221,671	....
Total damage to traction lines...					476,041	....
Total (including railroads and traction lines)...............					$180,873,097	....

*Includes smaller towns reported by officials to whom requests for estimates were sent. †Waterworks, sewers, roads, county bridges, street railways, etc. ‡Includes $150,000 for State canals in Ohio.

The estimate of railroad losses represents nine systems and the traction losses were compiled from information received from 65 companies. The estimates given are for actual damage only and do not include even all of such losses. No estimates of economic losses are given, although some were received. The losses of revenue by the railroad and traction companies probably amounted to at least one-half or two-thirds of the actual losses and possibly more. That the actual losses resulting from the flood of March-April, 1913, will greatly exceed $200,000,000 there seems to be little doubt.

ACTUAL AND ECONOMIC LOSSES

The damage caused by floods may be divided into two classes—actual and economic. Under "actual damage" are classed direct physical losses that are tangible and apparent, a portion of which may be measured in terms of the expenditure required to restore the thing damaged to approximately its condition before the flood; the rest may be measured in terms of the monetary value of the thing lost or destroyed.

Under the classification "economic damage" are placed those indirect losses that are, in a sense, presumptive. These include losses due to suspension of business and social relations in the flooded area and in places having such relations with that area; losses due to decreased confidence in the security of the localities flooded—especially the towns and cities, which may be termed lost prestige; losses due to general depression and decreased initiative throughout the flooded districts; and losses due to a materially decreased property valuation.

In addition to these losses, there is a loss of wild animal life of which it is practically impossible to get any idea.

Finally, the pitiful loss of human life is the most serious of all. Although a valuation is sometimes placed upon human life, it seems that any attempt to judge this loss in terms of money is entirely out of place here.

DAMAGE FROM SIMPLE INUNDATION AND EFFECTS OF CURRENT

The damage by flood results directly from two things, simple inundation and the effects of the current. It is questionable which of the two causes the more damage. In simple inundation probably the most damage is caused by the yellow, slimy, fine, penetrating mud that is deposited everywhere. The effect of this mud in cities is almost inconceivable. There may be some gain in fertilization when it is deposited on farm land, but it is open to question whether or not its value as a feltilizer outweighs even the damage it does on the farm, to say nothing of its effect in cities and towns. Any consideration of this benefit to farm land appears simply an attempt to discover some small benefit in connection with the enormous loss.

The effects of the current are noted principally in the sweeping away of bridges, houses, and other structures, in the tearing up of city streets, and in the erosion of agricultural land—the top soil in many places being entirely washed away and nothing but a barren gravel bed left in the place of fertile land.

In considering damage by flood, it should be borne in mind that damage resulting from floods of a given and constant magnitude (for example) are ever increasing because of increases in the value of the areas flooded and of their contents.

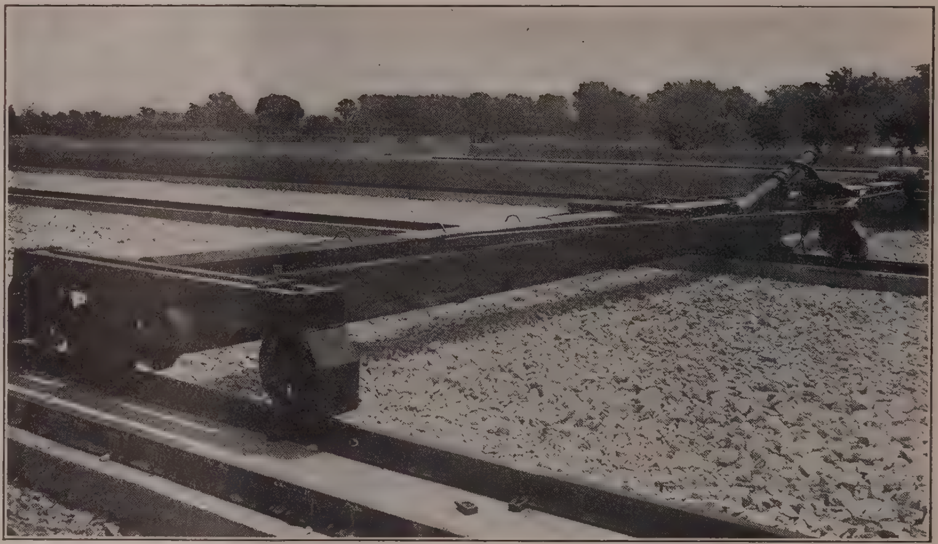
Thus, with the added possibility of floods of greater magnitude than have ever occurred in the past, it would seem wise and proper that a generous interpretation should be placed upon the amount of money to be expended for purposes of flood control in the Ohio Valley.

Travelers for Sewage Distribution

Abstract of Paper Read by Alexander Potter, Consulting Engineer, New York, before the American Society of Municipal Improvements Convention, Oct. 7

The city of Springfield, Mo., is located 240 miles southwest of St. Louis, among the foothills of the Ozark mountains, 1400 ft. above sea level. During the last decade the growth of the city has been very rapid. The population in 1900 was 23,000 and in 1910 it was 34,000. The present estimate is placed at 46,000. The area of the city is 14 sq. miles.

During the greater portion of the year the natural flow of all of the streams is so small that they are unable to assimilate the large quantities of sewage that are constantly discharged into them. In the spring of 1911 the nuisance from raw sewage discharged into these streams became so serious that the city appropriated $100,000 to construct sewage treatment plants at two sewer outlets.



Power-Driven Traveling Distributor at Springfield Plant

On account of the limited area available, it was deemed advisable to use intermittent filters instead of contact beds. The ordinary type of sprinkling filter could not be used, as such a filter requires a head of at least 5 ft. to operate the nozzles. Such a head could be obtained only by pumping. Mechanical distribution was therefore recommended. The distributor selected is operated with a head of only 12 in.

The plant consists of a grit chamber built in duplicate, two settling tanks of the two-story type, a sprinkling filter divided into six units, each 53 ft. 9 in. wide and 200 ft. long, sludge bed 0.35 acre in extent, and a final settling basin of 150,000 gal. capacity, located at the outlet, 3600 ft. from the remainder of the sewage disposal plant.

The grit chamber is constructed in duplicate. The flow is retarded sufficiently so as to retain only the suspended mineral solids which would interfere with the operation of the settling tanks.

SETTLING TANKS

The Springfield sewage tanks are neither square nor truly circular. Each unit is four-leaf-clover shaped, consisting of four semi-cylindrical segments 26 ft. in diameter. This type of construction is peculiarly well fitted not only to resist the water pressure from within, but also the earth pressure from without when the tank is below the ground and empty. The construction features of the tank are shown in one of the illustrations. The shell of the semicircular segments is 12 in. thick, reinforced vertically with ¾-in. bars spaced 3 ft. on centers and circumferentially with ¾-in. square bars spaced so that the unit stress does not exceed 14,000 lb. per square inch. The unbalanced tension at the point where the semicircular segments intersect is taken up by 1¼-in. circular rods embedded in concrete struts.

TIE RODS IN TANKS

The steel reinforcement in these ties is designed to resist the tensile forces at the same unit stress as the circumferential reinforcement in the shell. If this is not done, and different stresses are used for the tie rods than are used for the shell, the shell, instead of being subjected to simple tension, will be subjected to bending. The tie rods are fastened to a steel plate 8 in. wide, ⅞ in. thick, bent to a 5-in. radius. By means of double nuts the reinforcement is kept in accurate alignment which insures equal distribution of the tension among the larger number of tie rods.

The cylindrical segment must be free to expand in all directions. If the expansion is in any way prevented by interior construction, such as the troughs, false bottoms, or beams, the shell, instead of being under tension only, as contemplated by the designer, will be subjected to heavy bending, often sufficient to cause the fracture of the structure. To permit of the free expansion of the shell when under internal pressure, all interior construction, except at the intersection of the ties and struts with the shell, is separated from the shell by expansion joints.

OPERATION OF TANK

After passing through the grit chamber, the sewage enters the distributing trough, which is 2 ft. wide, and holds, under normal conditions, about 2 ft. of liquid. Eight 8-in. circular openings, placed in the side of the trough near the bottom and on the side next the outer wall, admit the sewage to the settling compartment. At the end of the trough is an additional opening, placed so as to be but half submerged, so that whatever scum may tend to collect in the distributing troughs is carried over into the settling compartments. Each settling compartment has a capacity of 111,-

000 gal., which gives an average period of retention of 1.4 hours when the plant is operated at 4,000,000 gal., its capacity. The flow in the settling compartment is parallel to the direction of the slot. To prevent eddies and other disturbances from being set up in the settling compartment which might interfere with the settling efficiency, the liquid is admitted to the settling compartment in a direction opposite to that which it must take in passing through the compartment. The clarified sewage leaves the settling compartment over eight 15-inch weirs discharging into the collecting trough.

The presence of the concrete struts in the settling compartment does not in any way interfere with the efficiency of the tank. Where necessary they can be capped with wedge-shaped pieces of concrete having slopes of at least 45 deg. In that circular segmental area between the distributing trough and the shell of the tank all of the floating matter is collected and forms a very heavy scum, requiring slight attention from the operator.

Interior of Clover-Shaped Settling Tanks, Showing Tie Rods

Vertical Circulation

To increase the settling efficiency of tanks of the type described Mr. Potter uses vertical circulation. The amount of sewage thus circulated is very small and does not exceed 2 per cent of the total amount of the sewage treated. To accomplish the vertical circulation mentioned, a 6-in. cast-iron main with four 4-in. circular openings is laid in the digesting chamber of each tank, about 6 ft. above the slot. This circulating main terminates in a small chamber located in the segment between the collecting trough and the shell; the chamber has an adjustable weir to control the flow from the digesting chamber into the collecting trough. In the Springfield plant the liquid thus drawn off is mixed with the effluent from the settling compartment and the resultant mixture is treated on the sprinkling filters. Circulation such as that used in Springfield is especially of value when the sewage to be treated reaches the plant in a more or less septic condition. The Springfield plant has not been in operation long enough to determine the exact value of the circulation system.

The suspended organic and mineral matter which settles out of the sewage in the settling compartment slides down the inclined plane through the 8-in. slots located in the bottom of the wedge-shaped settling compartments into the sludge digesting chamber. The sludge digesting chamber has a capacity of 105,000 gal. below the opening.

To reduce the loss of head to a minimum power-driven mechanical distributors are used to distribute the sewage on the filters. These distributors were manufactured by the Ham Baker Company, of London, England. They are designed to distribute the sewage upon the beds with a loss of head not to exceed 12 in. when the liquid is applied at the maximum rate of 720 gal. per square yard per day. Each distributor, as shown in one of the illustrations, is supported on three rails, spaced 25 ft. on centers. The length of the travel is 200 ft.

The effluent from the settling tanks is conveyed by a 24-in. reinforced-concrete pipe to a main distributing trough located at the north end of the filters. The lateral distributing troughs which supply the traveling distributors are fed by 3-ft. weirs from the main distributor. The object of these weirs is to insure a uniform distribution of the liquid to the distributors.

The depth of the filtering material ranges from 6 ft. 6 in. in the center to 6 ft. at the sides. Instead of using 6-in. channel tile for the filter underdrains, the contractor was given permission to construct 6-in. semicircular channels in the concrete floor and cover them with vitrified tile slabs. The main collectors are semicircular in shape, 18 in. in diameter and of variable depth, the distance between them being about 25 ft. The rails on which the distributors travel are supported by concrete girders carried by piers spaced 12 ft. 5¼-in. centers. The area covered by each distributor is inclosed by an 8-in. concrete wall. The winter temperature of Springfield is sometimes so low that it may be questionable as to whether the traveling distributors can be successfully operated in extreme weather. Should the traveling distributors go out of commission or any of them break down, it is possible to utilize the filters or any unit thereof as a contact bed to be operated by hand, suitable gates being provided for this purpose.

Extending down the center of the filters between two of the traveling distributors is a 3-ft. rectangular conduit in which the normal depth of sewage is 16 in. A cast-iron siphon, 24 in. long and 8 in. in width, conveys the liquid from this trough to the distributor. This siphon is provided with a gun metal air cock and brass air exhaust pump for starting the flow. The siphon discharges into the feed tubes, of which there are two. These feed tubes are made of wrought iron 3/16 in. thick and have an external diameter of 7⅜ in. The feed tubes are supported at each end and at the center by a cast-iron carriage braced together by rolled steel beams so as to form a rigid structure. In each feed tube just above the center are located ⅝ x 4-in. orifices, spaced about 15 in. lengthwise. The even distribution on to the beds is accomplished by a distributing tube 2½ in. in diameter, located between the feed tubes. This distributing tube is built in sections and can be raised or lowered as required to control the flow of sewage upon the beds. The feed tubes are protected with galvanized sheet iron covers provided with hinged access doors. The protection extends to within 1 in. of the surface of the bed in order to conserve the heat in the sewage as much as possible, especially during the cold weather. It also acts as a preventive of flies. A space is provided between the two channels suppporting the feed tubes, which during the cold weather is to be filled with moss, leaves or other insulating material.

Each pair of distributors is operated by an endless wire cable. All three sets of cables are driven by one 6-hp Otto gasoline engine, which gives the distributors a speed of 38 ft. per minute. The change in direction of the distributors is accomplished by means of a reversing lever.

The distributors have realized every expectation. Less than 2 hp is required to drive all six distributors. Mr. Potter beleves that the distribution of the liquid over the bed is more uniform than can be obtained by the methods now in use in this country.

This is the first time that power-driven traveling distributors have been used in this country. The range of temperature at Springfield makes this installation an important one as indicating possible limitations of service in extreme winter weather without covering the filters.

The plant was constructed by J. C. & E. T. Likes, contractors, of Des Moines, Iowa. The cost was $76,063. Mr. Potter acted as consulting engineer; his principal assistant, Mr. A. H. Beyer, was in charge of the details of design, and Mr. H. C. Atwater was resident engineer.

New York City Subway Situation

There is now under contract $83,000,000 worth of work on the new subway lines of the dual system and an average daily force of 7,000 men is employed thereon. In most cases the contractors are working two shifts, so that the work is going on night and day. Of the $83,000,000 worth of work, about $38,000,000 is on lines to be operated by the Interborough Rapid Transit Company and $45,000,000 on the lines to be operated by the New York Municipal Railway Corporation. Of the latter, however, the Fourth Avenue subway in Brooklyn and the Center Street Loop subway in Manhattan, costing together about $28,000,000, are practically completed. Of the men employed 4,700 are at work on Interborough lines and 2,300 on New York Municipal lines. It is estimated that the construction work on the city-owned lines will cost about $200,000,000. There is, therefore, more than one-third of the value of this work already under contract. Of the remainder, to cost $117,000,000, it is expected that more than one-half will be under contract before the end of the year, so that by that time actual construction work will be in progress on three-quarters of the city owned lines.

Separate and Combined Sewers

Abstract of Paper Presented by John H. Gregory, Consulting Engineer, New York, before the American Society of Municipal Improvements Convention, Oct. 7

Sewage treatment works cost money. It is, therefore, desirable to keep them as small as possible, and in order to do this the volume of liquid to be handled must be kept at a minimum. Rarely, if ever, would it be the case that all of the storm water would have to be treated; hence in this discussion the question of treating other than the first wash of the streets, in addition to the sewage, will not be considered.

With a separate system the volume to be handled at the treatment works is the total sewage flow in the sanitary sewers. The liquid is made up of house sewage, ground water leakage and trade wastes. The flow may, however, be increased in times of storm by taking in the first wash of the streets from the storm water drains should it be found necessary or desirable to treat the first wash.

With a combined system, under dry weather conditions, the volume to be handled ordinarily is what is commonly spoken of as the dry weather flow and is also made up of house sewage, ground water leakage and trade wastes. In times of storm, however, the flow in the combined sewers is increased by the storm water from the streets. The liquid then consists of a mixture of house sewage, ground water leakage, trade wastes and storm water.

Storm Water

The effect of the storm water in combined sewers is two-fold—it not only increases the volume of liquid flowing, but it changes its character. The first wash from the streets is often exceedingly foul and may increase the organic content of the liquid flowing in the sewers, giving what may be called a stronger sewage. As more and more storm water enters the sewers the storm water becomes cleaner and cleaner and with the greatly increased flow in the sewers the organic content of the liquid is decreased, resulting in what may be called a weak or dilute sewage.

The volume of liquid to be handled at the treatment works from a combined system depends on whether only the dry weather flow or the dry weather flow plus some storm water is to be intercepted. If only the dry weather flow is to be intercepted then the volume to be handled at the treatment works would, in general, be substantially the same from the combined system as from the separate system.

One fundamental difference between the two systems, however, exists. With the separate system no raw sewage escapes to the streams or water courses, while with the combined system raw sewage must at times be discharged into them. If it is planned to intercept only the dry weather flow, then, during storms, just as soon as the flow in the combined sewers exceeds the maximum rate of dry weather flow, the surplus flow, over and above that which can be intercepted, escapes, with the result that a mixture of sewage and storm water must reach the streams.

It is true that the overflow of raw sewage from combined sewers into the streams ordinarily would take place only during periods of storm, but even the occasional discharge of raw, unscreened sewage into a stream is a question which must be carefully considered. As far as the temporary reduction of dissolved oxygen in the stream is concerned no harm probably would be done, but floating particles of paper and fæcal matter are offensive to the sight. If, however, the stream into which the overflow of sewage would take place is sluggish and with but little velocity it may easily be that the continued overflow of sewage into it from time to time with the accumulation of sludge deposits on the bottom, would lead to offensive conditions.

With a combined system, in order to reduce the number of times during the year that raw sewage would overflow, it might be planned to intercept some storm water as well as the dry weather flow. One direct effect which this would have on the sewage treatment works would be to increase their size, and consequently their cost, over and above that which would be required if the separate system had been adopted.

If it is found desirable or necessary to intercept and treat the first wash from the streets the separate system is more advantageous than the combined system, as by its adoption no overflow of raw sewage to the streams will take place. The storm water drains receive only storm water and the first wash from the streets can be intercepted in the storm water drains and discharged either into the sanitary sewers, or into the intercepting sewer leading to the treatment works. As the flow in the storm water drains increases, the surplus water, over and above that intercepted, overflows to the streams but carries no sewage with it.

Trade Wastes

The separate system, under certain conditions, offers greater flexibility in the disposal of trade wastes than does the combined system, unless the first wash of the streets is to be intercepted and treated. Some trade wastes are offensive and if discharged into the sewers in such a condition must be treated. On the other hand some trade wastes are inoffensive and can be discharged direct into the streams without causing any nuisance or trouble.

With the separate system the offensive trade wastes can be discharged into the sanitary sewers and the inoffensive wastes into the storm water drains. The offensive trade wastes only would then be carried to the treatment works. With the combined system all of the trade wastes, the inoffensive as well as the offensive ones, would have to be intercepted and carried to the treatment works, with the result that the treatment works would have to be somewhat larger in size, and hence would cost more, than would be the case if the separate system had been adopted.

With a community which is largely residential in character, the volume of trade wastes would affect but very little the total sewage flow. With a manufacturing community, however, the trade wastes might amount to quite a large percentage of the total flow and in extreme cases might equal in volume the house sewage. Under such conditions it is evident that, if any considerable percentage of the trade wastes is offensive, separate sewers would be of decided advantage, as they would permit of the inoffensive wastes being discharged direct into the storm water drains, the offensive wastes only being discharged into the sanitary sewers and by them carried to the treatment works.

With a combined system, automatic regulators are generally used on the connections between the combined sewers and the intercepting sewer to limit the amount of flow from the combined sewers to the intercepting sewer. With a separate system automatic regulators are not required unless the first wash from the streets is intercepted in the storm water drains. Automatic devices in sewers, as a general proposition, no matter how well designed, are to be avoided wherever possible.

The presence of grit at a sewage disposal works is generally more or less of an annoyance, especially when the sewage has to be pumped and passed through settling tanks. With combined sewers, receiving storm water from the streets, a considerable amount of grit must be expected to reach the disposal works, not only during wet weather but during dry weather also. With separate sewers the amount of grit received at the disposal works is relatively small unless the first wash from the streets is intercepted in the storm water drains and carried to the disposal works.

Sand Catchers

It has been suggested that a considerable amount of grit could be prevented from reaching the disposal works from combined sewers by inserting a catch basin or sand catcher on each connection between the combined sewers and the intercepting sewer. It is probably true that such would be the case, but it is a question whether this would be a good method of removing grit. In the first place, these sand catchers would sooner or later fill up and unless cleaned at proper intervals would fail to serve the purpose for which they were built. Again, it is very probable that more or less organic matter would be deposited in them, especially when only the dry weather flow, consisting mainly of sewage, was passing through them. The retention of organic matter would lead to offensive conditions as soon as putrefaction began.

The inserting of sand catchers between storm water drains and an intercepting sewer would seem to be a more practicable proposition, as the possibility of retaining offensive matter from sewage would then be eliminated. The sand catchers would still, however, have to be cleaned in order to make them effective.

With combined sewers or with separate sewers in which the first wash from the streets is intercepted in the storm water drains, grit must be expected. Such being the case, it is a question if the simplest way of handling the grit is not to admit it into the intercepting sewer from the combined sewers, or storm water drains, without attempting to intercept any portion of it, and then to transport it with a good velocity in the intercepting sewer direct to the sewage disposal works. Even with sand catchers on the connections between the combined sewers or storm water drains and the intercepting sewer, enough grit is sure to reach the sewage disposal works to require its removal before the sewage is pumped or passed through settling tanks. The removal of grit at one point instead of at numerous points has many advantages.

With sewage from a combined system, the volume of sludge accumulating in settling tanks is greater than with sewage from the separate system. It may even be nearly twice as much, as has been found to be the case by comparison of the quantities of digested sludge removed from different Imhoff tanks, some of which have been connected with combined systems and others with separate systems. The greater volume of sludge from the combined system may mean that less organic matter has reached the streams than would have been the case if the sewers had been built on the separate system. If, however, the first wash from the storm water drains of a separate system is intercepted and carried to the treatment works, then the volume of sludge should be approximately the same as if the sewage came from a combined system. Similarly the amount of organic matter reaching the streams should be approximately the same, although it is possible that it might then be somewhat less.

No hard or fast rules can be given for the adoption of either the combined or the separate system. Each has certain advantages. These, as well as local conditions and cost of construction and operation, must be taken into account. Other things being equal, especially as more and more attention is being given to the question of sewage disposal, the separate system seems to offer greater advantages. With either system, however, to secure satisfactory results too much stress cannot be laid on the necessity of not only proper design but satisfactory maintenance and operation.

Niagara Falls Power Company's New Turbines

Ten 5500-Horsepower Waterwheels with 54-Inch Diameter Runners and Cylinder Gate Speed Control to Replace Original Installation

The Niagara Falls Power Company has recently completed the installation of ten 5500-hp. water turbines in its power house 1 at Niagara Falls, N. Y. The new turbines displace the ten turbines of the same output which formed the original installation of the company.

The old turbines were of the Fourneyron type, designed by Faesch & Picard, of Geneva, Switzerland, and built and installed by the I. P. Morris Company, of Philadelphia. These old turbines, the first of which was in commercial service in 1895, performed in a very satisfactory manner during their seventeen years of continuous service, and upon dismantling the runners were found in excellent condition, good, in fact, for several years longer. The efficient service rendered by the original turbines was the result of good design coupled with the good material and workmanship required by the late Dr. Coleman Sellers, formerly chief engineer of the Niagara Falls Power Company.

View of Assembled Turbine

It, however, became apparent to the power company that by installing Francis type turbines with draft tubes in place of the Fourneyron type the efficiency of the plant would be increased and its cost of maintenance decreased, both to an extent that the alteration would be justified.

Designs of the new turbines were made and the contract for one experimental unit was placed with the Bethlehem Steel Company. The experimental turbine was placed in operation in October, 1910. It was carefully tested for efficiency and in service, with the result that nine additional units of similar design were ordered from the same manufacturer.

The new units were installed and placed in service without interruption to the output of the plant, and well within the estimated cost and time of construction, and the increase in efficiency of the plant which was predicted has been fully realized.

The old penstocks which conduct the water to each turbine have been retained, although they had to be shortened to adapt them to the higher elevation of the turbines made possible by the use of draft tubes. The old shaft between generators and turbines, with its guide bearings, is continued in use. The thrust bearing, however, as well as the governor on each reconstructed unit, is new.

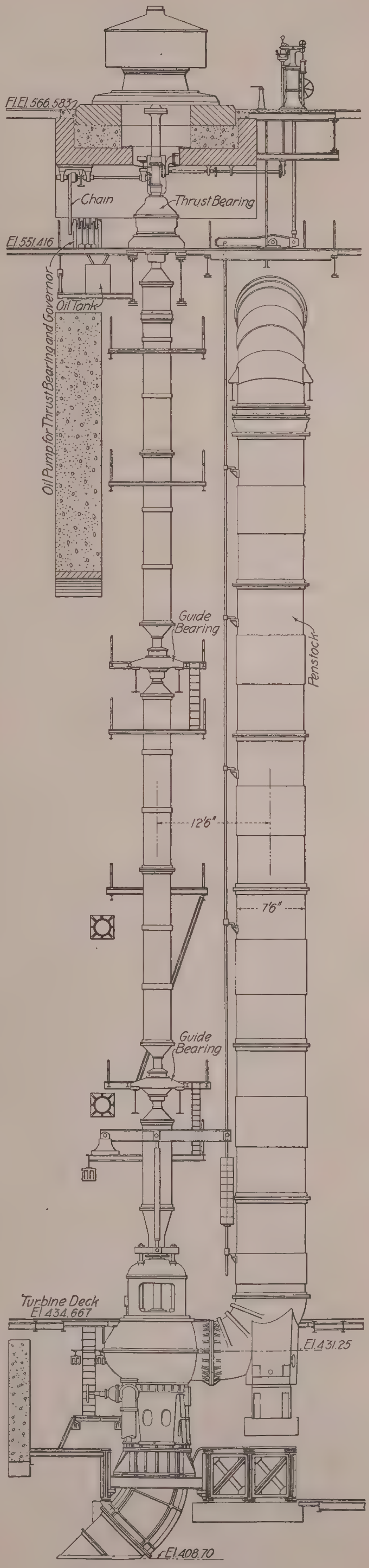
Thrust Bearings and Governors

Each thrust bearing is of a combination oil-pressure roller bearing, which carries the entire revolving load of about 175,000 lb. at 250 r.p.m. Besides giving in reality two thrust bearings, each capable of carrying the load, it permits the use of only a single oil pump to supply oil under pressure to both governor and thrust bearing, thus simplifying the high-pressure system.

The governors are of the oil-pressure type, the same as those designed in 1902 by Escher Wyss & Company for use in power house 2 of the Niagara Falls Power Company. The governor heads, including the flyball element, and the valves with their mechanisms were manufactured in the designers' shops in Zurich, Switzerland, while heavier parts, including the "servo-motor," were constructed in the machine shop of the power company.

Each reconstructed unit is provided with a triplex, single-acting, high-pressure oil pump, which provides oil for both thrust bearing and governor. The pumps are of special compact design and carefully constructed for service in the shops of the power company. Each pump is driven from the main turbine shaft through a rawhide gear and Renold chain, thus eliminating practically all the noise usually found in power plants employing pumps driven from the main shaft.

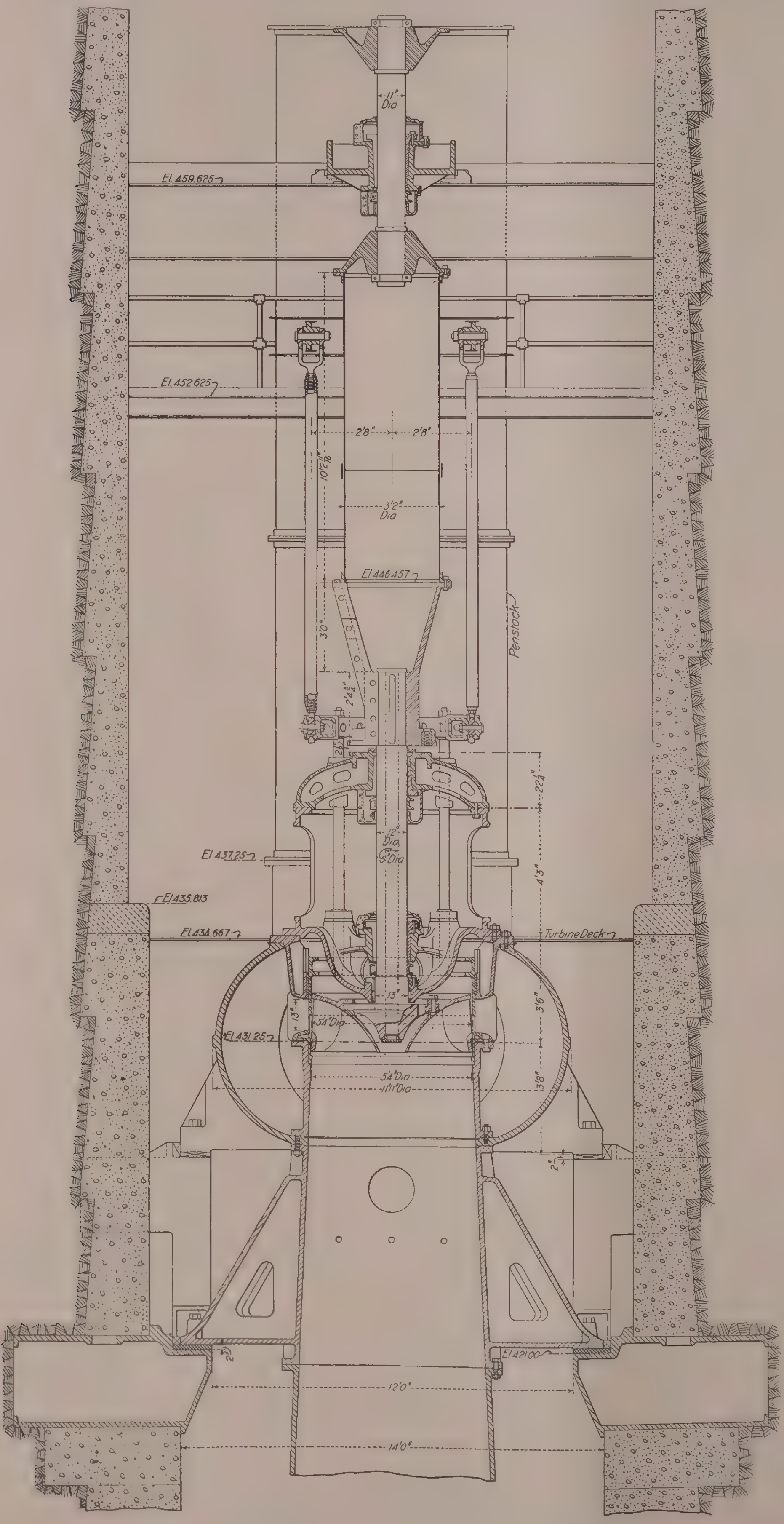
The accompanying drawing shows a cross-section of the lower part of the wheelpit, including a cross-section of one of the turbines. The simplicity and accessibility of the working parts of the turbine are to be noted.



Elevation of Turbine in the Pit

By disconnecting a shaft coupling, two valve-connecting rods and one flange joint, all the working parts can be lifted out and carried by the crane from the wheelpit. This construction also permits assembling of the working parts in the machine shop and their transportation and erection all in one piece. The parts thus assembled and resting on the power-house floor ready for lowering in the wheelpit are shown in the photograph.

Another point of interest in the turbines is the use of an old-fashioned method of speed control, namely, the ring valve interposed between turbine runner and distributor. While the ring valve is possibly higher in first cost than the usual form of turbine-regulating mechanism, its cost of maintenance is low, and, above all, it insures continuity of service, upon which the power company places the greatest importance. The turbines are required to work without the protection of inlet racks, and experience has shown that they will run without damage from ice, logs, stones and other débris usually encountered in power-plant operation. The use of the ring valve has the disadvantages that the efficiency is lower at partial load than with other types of regulation, and that when running at partial loads the wear of the runner is somewhat increased; but in turbines here described these disadvantages are of little importance on account of the exceptionally high load factor on the plant.



Sectional Elevation of Turbine, with Gate Arrangement

The turbines were built under rigid specifications, and both workmanship and material were closely inspected in the shops. The turbine shaft is of oil-tempered nickel steel, with its wheel hub forged solid with it. The distributor is made in one piece, of cast steel, and the runner is of special bronze. The ring valve is of cast steel and is provided with four bronze jacketed valve stems. All fittings are of bronze, and bronze nuts are liberally used.

An accompanying illustration shows the arrangement adopted for units 1 to 4 in the wheelpit. Units 6 to 10 are similar in arrangement, except that the draft tubes are somewhat longer. The draft tubes of the turbines in the downstream end of the wheelpit discharge the water at a higher velocity than those in the upstream end, which results in a higher efficiency than if all the draft tubes discharged at the same velocity. The discharge of the draft tubes in the direction of flow in the wheelpit has increased the efficiency of the plant in a marked degree over the efficiency with the old Fourneyron turbines.

The reconstruction of the machinery, including full details of turbines, combination oil-pressure roller thrust bearings and triplex oil pumps, was especially designed for the Niagara Falls Power Company by Mr. Charles C. Egbert, consulting engineer, of Niagara Falls, N. Y. The work of reconstruction was carried out by the regular staff of the power company, under the direction of Mr. L. E. Imlay, the superintendent.

Pontoon Bridge across Panama Canal

After the removal of the present bridge at Paraiso a railroad track and highway will be carried across the Panama Canal at an elevation of about 113.5 ft. on a temporary wooden pontoon bridge patterned on the type used for many years by the Chicago, Milwaukee & St. Paul Railway. The bridge, according to the "Canal Record" will be proportioned for a train load of 4000 lb. per linear foot, and will contain about 600,000 ft. of yellow pine or fir timber and 375,000 lb. of iron and steel. The floor will be carried on wooden trestles 14 ft. apart seated on the deck of a 55 x 378-ft. wooden scow, 6 ft. deep. The scow will be trussed under the trestle bents to distribute their loads, and will be braced every 2 ft. between trestles. The structure will be braced longitudinally by two trusses with their bottom chords on the bottom of the scow and with their top chords acting as track stringers.

The pontoon will be revolved horizontally about a fixed pivot, and a recess will be provided in the canal bank to receive it. Mr. Henry Goldmark, engineer in the first division, is directing the design of the bridge.

Book Reviews

The Bureau of Industrial Research, Washington, has issued a bulletin entitled "Pure Iron vs. Copper-Bearing Steel," by Dr. Allerton S. Cushman, Director, discussing the claims recently made for the latter material. Dr. Cushman's findings are adverse to copper-bearing steel as far as material resistance to corrosion is concerned. Those interested in the subject of corrosion will do well to get a copy of the bulletin. (Washington, D. C., Bureau of Industrial Research.)

"Safety First" is the title of a booklet by George Bradshaw. The author's attention is devoted to the dangerous practices of train, shop and repair men. Short, concise paragraphs are placed opposite illustrations of the right and wrong ways of doing things, and the results of the latter. The booklet contains 130 pages and 99 figures, and covers its field thoroughly. (New York, McGraw-Hill Book Company. 50 cents net.)

Modern Pumping and Hydraulic Machinery. By Edward Butler, M. I. Mech. E. Cloth, 6 x 9; 473 pages; 345 illustrations. New York, J. B. Lippincott Company. $5.50 net.

The book very satisfactorily describes pumping engines and pumps of various types used for a great variety of purposes. It treats also of special pumping devices, such as air-lift pumps, pumps for raising petroleum, injectors, hydraulic rams, and steam or gas power displacement pumps. It devotes one chapter to hydraulic power wheels. The book should be found to be of considerable value to the practising engineer, for reference for students in engineering and of some help to a designer. The illustrations are abundant and good.

The Rolling Mill Industry. By F. H. Kindl. Cloth, 6¼ x 9¼; 76 pages; 27 illustrations. Cleveland, Penton Publishing Company. $2 net.

As the author states in his preface, this book is a summary of American rolling mill practice, its development being traced from the beginning to the present day. The first chapter is historical, starting from the first plate mill, built in Germany in 1780, and coming down to modern applications of electricity. The next chapter classifies rolling mills, and the third chapter is devoted to finished products, giving statistical tables of the annual output of various steel products. The wire industry, the tube and pipe industry and the tin and terne plate industry are each given a chapter. The book closes with a variety of useful statistical information, including figures for the production of iron ore, coal, coke, pig iron, all kinds of steel, rails, structural shapes and other steel products for the years 1910 and 1911, and a condensed table of the world's production by countries for 1910.

The Field Engineers' Handbook. By G. Carveth Wells and Arundel S. Clay. Leather, 4 x 6½; 227 pages; 79 illustrations. New York, Longmans, Green & Co. $2.10 net.

In the authors' words this book is intended as a "handbook on engineering surveying," although it might be more properly described as a handbook on railway surveying, since it treats almost exclusively of railway surveying. It is applicable chiefly to practice in the British Colonies. While the subject matter has been arranged clearly, the treatment is in most cases quite elementary, and oftentimes incomplete. The most serious shortcoming, however, is the almost complete lack of tables. Practically no trigonometric or earthwork tables, and only a few tables of curve-functions, are given. For this reason the book is of very limited use in the field. Its scope is further restricted by omission of much of the theory of the simple curve, all of the compound curve and the reversed curve, and by failure to take up such matters as turnouts and crossings. The chapters on astronomy and the determination of azimuth and time give much useful information, but they also must be supplemented by tables in order to obtain results in any specific case.

The Practical Railway Spiral. By L. C. Jordan, B.S., C.E., Principal of Civil Engineering Department, Heffley Institute, Brooklyn, N. Y. Leather, 4 x 6¾; 155 pages. New York, D. Van Nostrand Company. $1.50 net.

This work is a careful development of a practical railroad easement curve. In the preface and introduction the author states concisely the general considerations that should fix easement standards, and justifies his spiral by setting forth the variety and inconsistencies of the standards now in use. His spiral is a practical modification of the cubic parabola, with smaller rates of change for each end to accommodate the short vertical curves in the outer rail. He also advocates in general uniform lengths of spirals for all curves, although his system can be used for any length that is a multiple of 75 ft.

Starting with an analysis of the reasons for and the utility of superelevation and curve easements, he explains at length the easement he advocates, derives the necessary formulæ, and explains their use. A short but useful chapter is devoted to various methods of fitting spirals to existing tracks laid out without them.

About one-third of the book is given to the text and the spiral tables. The rest of the volume is devoted to useful tables of curve data, logarithms and trigonometric functions usually found in such works. The tables are less complete than in some of the other field books, but the natural functions of angles are given to seven decimal places.

Calculus. By William S. Franklin, Barry MacNutt and Rollin L. Charles of Lehigh University. Cloth, 5¾ x 8; 294 pages; 122 figures. South Bethlehem, Pa., F. R. Ashbaugh, Lehigh University Supply Bureau. $2.

This volume is an elementary treatise of differential and integral calculus. The subject matter treated is differentiation, integration, partial differentiation and integration, expansion in series, ordinary differential equations and vector analysis. The intent of the authors is to present the fundamental principles underlying these various operations in such a manner that the student may strive for their mastery and thus make calculus a powerful tool in the solution of engineering problems, rather than the cumbersome and much detested one the majority of the engineering students of to-day regard it. Whether this has been accomplished in this text can only be determined by the results obtained from its use, but the reviewer feels that the authors in presenting this book have taken a step in the right direction in making calculus a subject of some meaning to the average student.

While the treatise is necessarily elementary, yet if the student masters the subject matter as presented he will find himself sufficiently prepared to deal with most of the problems the engineer has to wrestle with. The text is undoubtedly destined to receive considerable criticism from the mathematician on the grounds of incompleteness and in some places fallacious statement; but the authors have anticipated them by pointing out these shortcomings in the preface.

While the text may not meet with the approval of or receive any extended use by mathematical students, yet the reviewer believes that as a text book for engineering students it will find a ready welcome.

Specifications and Tables for Steel-Framed Structures. (For Office, Warehouse and Manufacturing Buildings, Sheds, Docks and Structures Other Than Bridges.) By the American Bridge Co. of New York. Paper, 7½ x 5; 70 pages. New York, American Bridge Company of New York.

The American Bridge Company's specifications for steel structures issued Dec. 1, 1912, contained, besides several pages of requirements for designs, details of construction and workmanship, tables and diagrams of comparative allowable unit stresses for columns computed in accordance with half a dozen formulæ, tables of beam loads and of the strength of standard beam connections. These specifications conform largely to the most generally accepted standards for first-class work, combining practical and theoretical considerations. They are especially simple and direct without superfluous requirements. They are intended to form a convenient and authoritative basis for the engineers of the American Bridge Company, and for the use of architects and engineers associated with work likely to be fabricated in that company's shops.

A second edition of the specifications has just been issued, and in addition to the original data contains tables of riveted plate girders, columns and struts and roof and floor loads. There are 16 pages of plate-girder tables giving the section moduli. Dimensions and weight per foot of flange plates and angles and maximum end reactions are given for girders 24 to 48 in. deep with moduli varying from 136 to 1147. The requirements and properties of columns and struts are briefly reviewed and tables, figured in accordance with the bridge company's specifications, are given showing the dimensions, weights and safe loads for H-beam, I-beam, and riveted I-shaped columns up to 35 ft. in length. Typical details of bases, splices and beam connections for columns are also shown.

A unique table is given of the contents of storage warehouses, showing the weight per cubic foot and the floor load per square foot for piles of different heights of a large number of staple commodities classified under the general heads of groceries, dry goods, hardware, building materials, drugs and miscellaneous. The same table also gives the amount of live load per square foot of floor recommended for the different classifications, which varies from 200 to 400 lb. per square foot.

Another original table of very great convenience is one showing the minimum live loads per square foot of floor required by the building laws of Boston, New York, Philadelphia, Baltimore, Pittsburgh, Cleveland, Chicago, St. Louis and San Francisco for all the principal kinds of public and private buildings.

Special editions of the specifications have been issued for use in New York City, Philadelphia, Boston, and Chicago. They also contain special tables of safe column loads figured on the basis of the building laws which govern in each of those cities. These were prepared to facilitate the design of work controlled by such laws, while the corresponding tables computed from the bridge company's specifications are intended for work where the designer is free. In all cases tables of columns and girders are designed to use sections usually carried in stock or easily obtained from the rolling mills.

Letters to the Editor

Drilling Troubles

Dear Sir: In one of our limestone quarries we have a 10-ft. flint ledge which is giving us a great deal of trouble, breaking drill cylinders and also the steel. We are using a standard make of drill and at the utmost can make only 20 ft. of hole per day. Do you or any of your readers know of a machine or method than can make better time or some firm or superintendent that worked through such stone?

Ruecking Construction Company.
St. Louis, Mo.

Forfeiture of Certified Check

Dear Sir: In your issue of Sept. 13 Mr. Edward L. Bader seeks a reason why the lowest bidder should be rejected because on a previous contract between the same parties the contractor had abandoned the job and forfeited his certified check.

Councils and boards having power to award public-works contracts are generally authorized to award them to the lowest responsible bidder. The term "responsible bidders" is not generally defined, and if there is no statute in the State defining it more closely would be taken to mean a bidder responsible in the opinion of the awarding officer or board. Unless it could be shown that they were wilfully unfair in making the award to a bidder not the lowest it must be assumed that they acted sincerely. If they did act in good faith, it matters not on what they based their opinions. The fact that the same contractor did once before default, even though the State or town suffered no loss thereby, might seem conclusive evidence to them that he was not responsible, and hence their award could scarcely be attacked.

Knowing this, the disappointed contractor is not apt to attempt suit, and there is accordingly no recorded case on this point.

Brooklyn, N. Y. Bruno C. Lechler.

Proposed Test for Accuracy of Cement Sieves

Dear Sir: Could not something be done by your paper to bring about a closer concordance in fineness determinations in cement, particularly in the case of the 200-mesh sieve?

The practice of to-day is to have sieves approved by the Bureau of Standards, whose examination is thorough, as far as it goes, including the count of the mesh and the measure of the diameter of the wires. This is not entirely satisfactory, however, for the reason that it is possible to obtain a widely varying fineness on the same sample with two sieves, both approved by the Bureau of Standards, the discrepancy sometimes being as great as results of 85 per cent through one sieve and 80 per cent through another on the same sample of cement.

It appears to me that the solution would be not only to check the mesh and diameter of the wire but also the sieve by making a determination with it on a large standard sample of cement, most carefully prepared, and of a carefuly determined fineness. Only sieves which agree within, at least, a per cent in an actual determination on this standard sample would be approved. There would also be furnished a plus or minus correction (based on determination on the standard cement sample), to be used with the sieve.

There is no question that testers and engineers are much more interested in the uniformity of the results obtained with the sieves than they are with the mere details of the count of the mesh or determinations of the diameter of the wire. Those details would necessarily have to be correct to give uniformity of results; but experience has shown that it by no means follows that sieves showing, on examination, a mesh count and a wire diameter within specifications agree in results in actual determinations.

We are constantly having trouble throughout the United States through such differences, each laboratory invariably claiming Government approval of its sieves, and that, therefore, its sieves must be correct. We have many times taken such sieves and with the same tester on the same cement found extremely wide variations, as noted.

We believe that you will do the industry a great deal of good by having this brought to the attention of the engineers, as well as to the screen manufacturers and the Bureau of Standards.

Bernard Enright,
Director, Eastern Testing Laboratories.
Allentown, Pa.

[Mr. Enright's letter was submitted to a number of cement specialists. Their views follow.—Editor.]

Dear Sir: We are pleased to have an opportunity to reply to Mr. Enright's letter, as the matter of fineness determination is one to which we have recently paid some attention.

A few months ago a considerable number of sieving tests were made in our cement laboratory primarily to determine what variation in sieving value might be expected with sieves which receive the certificate of this bureau. The results of these tests were deemed of sufficient interest and importance to be published as a technologic paper of this bureau, which is shortly to appear under the title "The Variations in Results of Sieving with Standard Cement Sieves."

In carrying out these tests thirty-four No. 200 sieves were employed, twenty-one of which received the Bureau of Standards certificate. The maximum range obtained in sieving a carefuly prepared cement with these sieves was 1.75 per cent. While it is probable that the range throughout a large number of sieves may be slightly greater than this value, we believe that a discrepancy of 5 per cent is excessive and indicative either of careless manipulation or of defects in the sieves developed subsequent to inspection by the bureau. This opinion, however, does not alter the fact that verified differences of 2 per cent on "standard" No. 200 sieves are unfortunately large, and we have adopted the practice of determining corrections to the standard sieves used in routine testing, and applying these corrections in fineness determinations.

It has thus been established, as Mr. Enright points out, that mesh and wire measurements alone are not wholly adequate to determine the sieving values of sieves. In view of this fact the Bureau of Standards has recommended that a tolerance of 1 per cent be permitted in fineness determinations which are made according to the present specifications.

In conclusion it may be noted that the Bureau of Standards has for some time considered the feasibility of issuing a standard cement sample at nominal cost in order that the testing laboratories may check up their own sieves, but owing to pressure of routine and investigative work the matter has not yet been given the attention it deserves.

E. B. Rosa,
Acting Director, Bureau of Standards.
Washington, D. C.

Dear Sir: Referring to the letter by Mr. Bernard Enright on the standardization of the No. 200 mesh sieve, I would say that the test of fineness of cement as shown by sieves is not now considered of so much importance as formerly, because it is recognized that the real cementitious value of cement is dependent on the fineness of grains smaller than the finest sieve.

On the other hand, the object of any test is to show accurately the quality of the material, and our apparatus should be within the limits of accuracy needed to indicate this quality. While accurate calibration of each independent sieve would be of considerable value, especially so long as the sieve is practically new, I am of the opinion that results of sufficient accuracy for the purpose can be obtained by accepting the sieves from wire-cloth manufacturers by requiring them to maintain a very high standard. Uneven or imperfect mesh should be rejected and frequent special tests should be made to indicate to the manufacturers that accurate weaving is essential.

Boston, Mass. Sanford E. Thompson.

Dear Sir: The determination of the proportion of a Portland cement which will pass through a standard 200-mesh sieve is at best only a makeshift test for the effective fineness of a cement. It is probably true that the larger particles of cement which will just pass a standard 200-mesh sieve are of about as little value as a cementing material as those which remain on the sieve. If we could have a 500-mesh sieve we might, perhaps, by means of it determine the percentage of active material in a cement. But as we have no wire screens finer than 200 mesh, and as the sieve test has become so well established as one of the customary tests for acceptance of a cement, it is highly desirable that the test be developed to its highest attainable state of perfection and its use continued until we have a better and truer method of determining the amount of highly active particles in a given sample.

The present method of having the Bureau of Standards caliper the wire and count the meshes of a sieve leaves the question of the uniformity of size of the meshes still an open one. To measure the size of the openings directly would be an endless task and probably out of the question. The proposal that a comparison of sieves be made by passing a sample of finely ground material, either cement or something else, through them has received serious consideration both by the Bureau of Standards and others interested in the subject. It would seem possible to so compare the results obtained with two or more sieves, after check tests had been made with them on a standard sample, that a certificate of accuracy might be issued by the bureau. There appears to be small ground for objection to the use of a correction factor for such sieves as did not quite agree with the standard sieve. All such standardizing or calibrating tests should, however, be made by the Bureau of Standards and not by individuals or by commercial laboratories.

Another possible method of testing a sieve for accuracy of mesh and uniformity of opening would be to project the sieve by means of a lantern on a large screen, previously marked off as a perfect sieve would appear if projected on to it, and noting the variation between the projection of the sieve being tested and the theoretically perfect sieve marked on the screen. By this means the variation in the count in both directions would be at once revealed by interference, as would also the variation in the size of the openings.

As no screen cloth is perfect, all would fail to a greater or less degree when subjected to a test of this kind. It would be possible, however, to determine the degree of variation of a sample from the ideal screen cloth and to specify limits of allowable variation.

It would also be possible by such a method to select a piece of cloth as nearly perfect as could be obtained to serve as a standard for the comparison of other sieves by some such method as that described in the letter from Mr. Enright.

Undoubtedly greater accuracy is needed in our fineness test for cement. Ultimately we will probably have a practical test which will indicate the percentage of particles very much finer than those which will just pass the present standard 200-mesh sieve. Until that time arrives an effort should be made to improve the present test. The method of standardizing or calibrating by means of a standard sieve and a standard sample of fine material, if handled by an experienced disinterested operator, should tend to greater accuracy.

Cloyd M. Chapman,
Engineer of Tests, Westinghouse Church Kerr & Co.
New York City.

Dear Sir: In regard to the letter of Mr. Bernard Enright, director of the Eastern Testing Laboratories, referred to us for discussion, we would state that in our own practice we have failed to note as marked discrepancies in comparative tests with different standard No. 200 sieves approved by the Bureau of Standards as stated by Mr. Enright, although we have not had occasion to make very careful study of the matter.

It has been recognized by all testers of cement that the sieve test is at best only a makeshift and subject to errors, both from the character of the wire cloth and the personal equation involved in manipulation by different operators, and also because the sieving test fails to give a true indication of the amount of fine flour contained in the cement.

Taking up Mr. Enright's suggestion that the sieves be standardized by passing through them carefully prepared material of predetermined fineness, as well as by measurement of the wire and count of the mesh, we would state it has been the practice in our laboratories for a number of years to subject the sieves to a test along lines similar to those suggested by Mr. Enright. Noting, some 12 years ago, the great variation in the sieves then made, we ordered shipped us one dozen sieves, which were carefully tested, using the same material. A sieve was then selected which gave results closely approximating the mean of the twelve sieves under test. This was taken as our standard sieve, and by continuing the practice of ordering a number of sieves at a time and keeping only those which gave results closely approximating the sieve first selected, we have been enabled to keep our own results over a period of years closely comparative.

With the introduction of the sieves approved by the Bureau of Standards, this practice was dropped, but from the results obtained we believe the adoption of the suggestion of Mr. Enright would tend to insure greater uniformity between various sieves put on the market. We would point out, however, that the sieve does not remain constant, and its coefficient of correction would change with use.

Henry S. Spackman Engineering Co.,
Henry S. Spackman, President.
Philadelphia.

Principles versus Practice in the Teaching of Engineering

Dear Sir: I read with much interest the editorial in your issue of Sept. 27 on "Principles vs. Practice in the Teaching of Engineering." Your statement that "insufficient knowledge of principles spells disaster for the engineer who attempts to rely on current practice alone in contributing to the real advancement of the industry" sums up the situation in a most forceful manner. In this connection, the writer wishes to add a few remarks regarding the use by the inexperienced man of details of current practice and of empirical formulæ and data found in catalogs and journals.

In the field of reinforced concrete the promiscuous use of current details of design and construction, either correct or otherwise, by experienced as well as inexperienced men, has led to some amusing and some criminal designs. Over half of the failures in concrete structures have been caused primarily by such practices or by commercialized design, coupled with poor inspection and construction. Unless one is entirely familiar with the conditions which a certain detail was designed to meet, he should hesitate to apply it to the case in hand.

Nowadays we see altogether too many designs of continuous beams and girders where only one-third to one-half enough steel is provided in the top portions over the supports to care for the negative moments at the same unit stress as is used for the lower portions between supports. This is, more or less, the result of copying details without proper attention to the existing conditions. The lack of sufficient steel over supports is in general due to the failure of engineers to allow for the continuous action which is sure to occur in monolithic construction.

In other designs, the cross-sectional area of the steel over the supports is sufficient, but bars are bent down into the slab too rapidly or do not pass far enough beyond the supports to develop the required stress in the steel by bond. What we need in reinforced concrete design is more common sense application of the laws of mechanics and less "blind" copying of details and fine spun theory based on assumptions which vary greatly in every case.

The rapid growth of the concrete industry has given rise to the publication of many tables and so-called "labor saving devices" for the use of the designer. Some of these have been of great value on account of their completeness and because the assumptions upon which they are based and the limitations of their use have been clearly stated by the author. Then, again, some of them which are not so clearly defined, but apparently very simple to the inexperienced man, have led to poor and unsatisfactory designs and, instead of aiding the industry, have worked toward its disrepute. Every engineer should make it a rule not to use tables, diagrams or calculating devices made by others until he has satisfied himself that the underlying theoretical principles are correct and the limitations of use are clearly defined. The young engineer, if not over energetic, is very likely to fall into the habit of using "labor-saving" diagrams and devices, without troubling himself as to their authenticity. With these facts in mind, it is the duty of every engineer to impress upon the younger members of the profession, and particularly the student, the value and importance, as related to engineering problems, of the old slogan "Be sure you are right and then go ahead."

Chicago. Albert M. Wolf, C.E.

Pointed Observations on Brick Pavements and on the Rattler Test

Dear Sir: Having been interested in paving brick from a laboratory and practical point of view for several years, my impressions of the convention of the National Paving Brick Manufacturers' Association held recently in Cleveland are, first, a vague mixture of doubt as to whether or not specifications mean anything when applied to brick paving; second, a knowledge that brick can be used in making excellent streets, and, third, a certainty that the rattler test is an extraordinarily effective way of wasting time and unnecessarily condemning material.

The excursion the morning of Sept. 17 gave an opportunity of watching the process of grouting. Here on a side street, with a grade in excess of 2 per cent, was a gang of eleven men on exhibition; two tended the grout box, which was of recent construction and in accordance with specifications. Cement and sand of proper proportions were mixed in excellent manner to a creamy paste which would flow easily, while not separating. While the sand was much coarser than demanded by the National Paving Brick Manufacturers' Association specifications (which require that it pass a No. 20 sieve), there seemed to be slight difficulty in working it in a seemingly satisfactory manner. Then surprises followed one after another, leaving some of us rather bewildered.

Let me state here, however, that I am not certain that the Cleveland specifications are those recommended by the National Paving Brick Manufacturers' Association. But having been brought to this object lesson by that association, it was the general impression that here we were to see these specifications exemplified. But to resume.

Only one grout box was being used, although two are mentioned as being the fewest allowable. The box was dumped en masse, and when I asked an official of the association where the scoop shovels were he started on a hunt for the contractor. Evidently the search resulted in nothing of interest on this point, for the question remained unanswered. Unfortunately we did not reach the work in time to see the first application of grout, but while we were there two applications were made, and in neither case was the grout swept "lengthwise of the brick." The gang moved up the hill as quickly as possible, sweeping the grout in any direction that met their fancy. The first six men worked with bristle brushes, the last three with a very fine wire brush, there being no evidence of the use of a "squeegee or wooden scraper having a rubber edge," which was to be worked over the brick "at an angle with the brick."

In spite of these departures from the exact terms of the specifications the grouting was, superficially at least, very well done. The question arising as to whether or not the last grout had completely filled the interstices, I inserted the 2½-in. blade of my knife between two bricks in order to determine, if possible, the exact facts in the case; working it around briskly for a few minutes, I found that the grout in the immediate vicinity of this point settled as much as $\frac{3}{8}$ in.

At the request of one of the visiting bricklaying engineers two bricks were pulled in order to give an opportunity for the examination of the sand cushion and grout penetration. Except for the fact that the rolling had forced the sand cushion upward into the joints for a distance of about $\frac{1}{2}$ in. in places, the process seemed to have accomplished its purpose. The cushion, however, had a particularly pasty appearance, and an examination made it clear that the sand was not "clean, sharp sand free from loam or foreign matter" but had had mixed with it, either naturally or otherwise, at least 25 per cent of earth. This earth undoubtedly is an aid to the construction of a satisfactory sand cushion in spite of its being prohibited by the recommended practice of the National Paving Brick Manufacturers' Association. The loam gave it a quality which would permit rolling before laying the bricks and would perhaps prevent an undue procession upward when the brick themselves were rolled.

A knife blade inserted in this cushion was stopped at distances varying from 1 to $1\frac{3}{8}$ in. below the top surface. Although it may be that the cushion had been so perfectly rolled as to impede the point of the knife at this insertion, it seems more probable that the obstruction encountered was the concrete base. A 2-in. sand cushion is insisted upon.

Our next stop was in the district paved with the most perfect brick surface which it has ever been my pleasure to see—a true pleasure, indeed, for here were no evidences of those large disintegrated areas which are the despair of paving engineers in most localities. Instead an utterly uniform surface greeted us, the grout worn to precisely the same degree as the brick and contraction cracks appearing at such rare intervals and resulting in so little harm that they could be readily accepted merely as evidences of a saving human fallibility. To my utter surprise we were informed that these brick were laid on a sand cushion resting directly upon the soil, without the interposition of a concrete base. The soil could be examined in the grass plots at either side and seemed to be a sandy loam, shot with gravel pebbles ranging from $\frac{3}{4}$ in. down to the finest particles. It seems to me to be an economical blunder to put 65 cents' worth of good concrete under every square yard of brick pavement in any locality where soil conditions are similar to those found here, where these beautiful streets have been down for ten years with no sign of failure. Naturally the traffic was of the lighter class usually encountered in residence sections, but, as Mr. Will P. Blair said, these were the conditions met with in 75 per cent of all brick-paving work.

Another point which attracted my attention was that obviously soft brick lay immediately adjacent to evidently over-burned brick, but had worn to the same degree, the grouting between them maintaining its perfect filling of the joints in an astonishing manner. Some of the softer brick could be readily scratched with a knife blade, while the harder brick turned the steel in a manner that was satisfactory to everyone except the owner of the knife. Having supervised the testing of some two-thousand double charges of brick, I should judge that the softer brick would have shown a loss in excess of 32 per cent, and I would not hesitate in affirming that the harder brick would have been better than a so-called "20 per cent brick."

In the same neighborhood we had an opportunity of examining the condition of West Fourteenth Street, which carries, besides an extremely heavy traffic, two lines of streetcar tracks. This street is probably the most remarkable example of brick paving that may be seen in this country. Unlike the residence streets, it is laid on a 6-in. concrete base, and has preserved its perfection to such a degree that cracked brick along the tracks are hard to find. Why this type of construction should have been chosen, in preference to that employed in constructing the residence streets, in drawing a blanket specification is more than I can imagine. Surely it is poor engineering, positively criminal, in fact, to build a structure with a factor far in excess of that demanded by circumstances. If brick pavements can be laid for light traffic conditions without a concrete base, surely mention should be made of this fact and people should not be inveigled into wasting public money by the publication of a specification which makes it obligatory, without reference to favorable soil conditions such as prevail in some parts of Cleveland.

With two other engineers I broke away from the line of machines to make a visit to the garbage-reduction plant of Cleveland, which with its lack of nuisance and its marvelous economy should be a source of pride to the citizens. But in so diverting from the program I failed to see further construction work. I have learned, however, from certain gentlemen who followed the set program that most excellent streets were visited and that all actual construction work very closely paralleled that visited the first day.

The question now arises, as mentioned in my first paragraph, as to whether or not specifications mean anything when applied to brick paving. Certainly the members of the evidently competent engineering corps of the city of Cleveland are not fond of risking their reputation in order to avoid trouble with contractors. They do not seem to be the type of men who would allow anything except work of the highest character and promising to give the most satisfactory service. But nevertheless their practice is in dissonance with so much that is emphasized by the National Paving Brick Manufacturers' Association specifications that I wonder at the temerity of this association in forwarding their most carefully drawn-up documents.

Now as to the rattler test. Several men of the highest technical attainments and greatest respect for facts and accuracy have spent years and thousands of dollars in perfecting this test, both as to the machine itself and as to the method of conducting the test. It has been my fortune to participate with them in the work of the paving-brick committee of the American Society for Testing Materials, and I have carried away with me from these meetings an appreciation of their competency which is closely akin to jealousy. Even now I am convinced that the test is as closely guarded and as competently prescribed as any that are in use in this country. But as to the value of the test, that is another question.

The rattler test is purported to be a means of determining the strength and toughness of paving brick. The dimensions of the barrel, the charge and its character and several other features are of a purely arbitrary nature. What is desired in paving brick is a degree of the hardness possessed by the diamond and somewhat of the toughness inherent in rawhide—that is, theoretically. Practically it seems to make no difference, one way or another, whether the individual brick is hard or soft within certain limits which are wider than is usually thought permissible.

Some standard naturally must be adopted, but in my opinion that standard must abandon the use of the rattler. Just precisely what will be the nature of the final standard I am not in a position to say, but personally I would have more confidence in the judgment of an inspector of several years' experience than I would care to place in a dozen rattler tests. The brickmakers evidently know their business with few exceptions, and I firmly believe that if the National Paving Brick Manufacturers' Association should spend its efforts in maintaining even a fair standard of manufacture and give more attention to the work of construction its efforts would prove vastly more profitable to it, for the paving-brick industry is being ruined by forces not under the manufacturers' direct control at the present time.

It occurs to me that the fault of brick paving has its basis in the fact that competition among contractors has become so keen and has resulted in such low prices for the work that attention is given mainly to the perfection of methods which will allow the pavement to be put down at the least expense and not with the greatest efficiency. To lay a brick street which will give temporary satisfaction is a simple matter, but to bend every effort to the production of a pavement which will last and give satisfaction throughout its life is another matter. If some form of contract could be drawn up which would make it desirable for the contractor to see how well he could do the work and how faithfully he could observe the many fine points which contribute to a satisfactory pavement, the result would be all that could be desired, for evidently brick can be made into an almost ideal pavement.

One of the reasons prompting me to write the above lies in the fact that the engineer in charge of brick-paving construction received more than his share of criticism at the dinner held on the evening of the 17th. This was a trifle unfair, inasmuch as the available information on brick pavements is not extensive, and especially so since city engineers, as a rule, have very slight opportunity to examine the methods of other cities. In addition, I have tried to show that the adoption of the National Paving Brick Manufacturers' Association standard method is not the only way of attaining results, since these methods are violated continually in the city possessing probably the most remarkable brick pavements in the country. No doubt the engineer ultimately is responsible. However, there are many crimes where responsibility can be fixed but where no sane man would place blame.

MONT SCHUYLER,
Engineer in Charge, Municipal
Testing Laboratory.
St. Louis, Mo.

MAGNETIC ORE BEDS carrying a notable percentage of iron have been found during a geologic examination of the Blackfeet Indian Reservation. The beds occur in a prominent sandstone formation, traceable for many miles across the reservation. A sample showed 33.2 per cent iron and 10.6 per cent titanium oxide. Samples from other deposits in the vicinity show that a considerable tonnage, averaging abount 50 per cent, could be hand-sorted from these deposits, although the average would probably not exceed 30 to 40 per cent.